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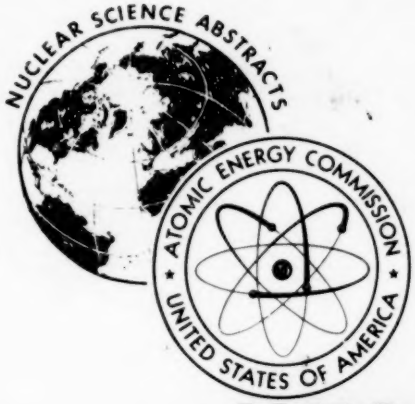


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**Volume 18 Number 5**

**Abstracts 6585–8043**

**March 15, 1964**

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Volume 18, Number 5, March 15, 1964

# NUCLEAR SCIENCE ABSTRACTS

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Volume 18, Number 5 March 15, 1964

# NUCLEAR SCIENCE ABSTRACTS

## BIOLOGY AND MEDICINE

### General

**6585** (ABCC-08-62) ABCC-NIH ADULT HEALTH STUDY HIROSHIMA 1958-60. CARDIOVASCULAR PROJECT REPORT NO. 6. HEART SIZE NORM. Shoichi Ueda, Walter J. Russell, and Katsuhiko Yano (Atomic Bomb Casualty Commission, Hiroshima). 21p.

Data on 13,000 persons 15 yr of age or older obtained during detailed clinical examinations, including radiologically recorded heart size, were correlated with sex, age, height, and weight of subjects to arrive at a standard heart size for Hiroshima residents. The information will be used in investigations of cardiovascular disease in the population. (C.H.)

**6586** (BNL-806(p.93-122)) LIFE SCIENCES. (Brookhaven National Lab., Upton, N. Y.).

Research activities of the Biology and Medical Departments are summarized. The biological effects of radiation and the use of isotopes for the elucidation of basic problems in biology are studied. Progress is reported on animal physiology, genetics, cell physiology, plant physiology, ecology, biochemistry, biophysics, radiodiagnosis, radiotherapy, radiology, autoradiography, metabolism, radiochemistry, medicines, irradiation techniques, and monitoring. (N.W.R.)

**6587** (NP-13406) THE BIOLOGY OF SPACE FLIGHT: AN ANNOTATED BIBLIOGRAPHY. Charlie M. Pierce, comp. (Lockheed Missiles & Space Co., Sunnyvale, Calif.). Apr. 1963. Contract AF04(695)-136. 317p.

Six hundred seventy-seven selected references are presented which are concerned with biology and space flight. Topics include food provisions, atmosphere control, waste control and water recovery, emergency survival systems, psychology, radiation and meteoroids, gravitation, magnetic fields, and exobiology. References to other bibliographies covering related subjects are included. The references are grouped by subject and arranged according to the first author. Indexes for corporate author, personal author, and subject are included. The general period of coverage dates from 1958 through 1962. (auth)

**6588** DOUBLE ISOTOPE TECHNIQUE TO MEASURE RENAL FUNCTIONS. SINGLE INJECTION TECHNIQUE WITHOUT URINE COLLECTION. James M. Stokes and Michel M. Ter-Pogossian (Washington Univ., St. Louis and Mallinckrodt Inst. of Radiology, St. Louis). J. Am. Med. Assoc., 187: 20-3(Jan. 4, 1964).

A double isotope tracer technique is described for the simultaneous measurement of glomerular filtration rate and renal blood flow by scintillation counting of the activity in blood samples collected serially after the administration of Na diatrizoate-$I^{131}$ and Na iodohippurate-$I^{125}$ in a single intravenous injection. (C.H.)

**6589** A VERSATILE SOLVENT TO REPLACE PHENOL FOR THE PAPER CHROMATOGRAPHY OF RADIOACTIVE INTERMEDIARY METABOLITES. G. J. Crowley, V. Moses, and J. Ullrich (Univ. of California, Berkeley). J. Chromatog., 12: 219-28(1963). (UCRL-10675)

A new solvent system, to avoid the use of phenol–water, was developed for the chromatography of complex mixtures of intermediary metabolites. The solvent contains ethylenediaminetetraacetic acid, ammonia, water, isobutyric acid, and four simple aliphatic alcohols, and is stable at least for many weeks. The advantages and properties of the solvent are discussed, and the mobilities in it of about one hundred metabolic intermediates are listed with reference to the mobility of aspartic acid. (auth)

**6590** A LOW-COST GROWTH CHAMBER FOR THE CULTIVATION FROM SEEDS OF GRASSES LABELLED WITH CARBON-14. E. Grossbard and G. E. Barton (Grassland Research Inst., Hurley, Berks, Eng.). Intern. J. Appl. Radiation Isotopes, 14: 517-25(Nov. 1963).

A growth chamber for the cultivation from seeds of grasses labeled with carbon-14 is described. The apparatus consists of a growth chamber, an infra-red gas analyser, an automatic electronically controlled system of generation and control of carbon dioxide concentration, a pressure regulator, and a nutrient supply operated by gravity. The plants are raised in hydroponic culture. The chamber combines simple construction with a considerable degree of automation and was built on a low budget without the aid of outside contractors. It proved suitable for the production of grasses labeled with carbon-14 to a satisfactory degree of uniformity. (auth)

### Ecology

**6591** (TID-19895) RADIO-ECOLOGY OF SMALL VERTEBRATE SPECIES UNDER NATURAL ENVIRONMENTS. Progress Report, December 1, 1962 to November 1, 1963. C. A. Tryon, Jr. (Pittsburgh. Univ.). Contract AT(30-1)-2579. 29p.

Information is summarized on the ecology of the pocket gopher (Thomomys talpoides), and the mountain ground squirrel (Citellus armatus) along an altitudinal transect in the Beartooth Mountains of northwestern Wyoming and

of the eastern chipmunk (Tamias striatus) in Crawford County, Pennsylvania. These animals will be used in experimental radiation studies of free-ranging small mammal populations. The individuals of these species are of suitable size for handling and irradiating, can be captured and recaptured readily, and the adults have an individual territory in which they remain throughout their lifetime. These species have a geographic range that permits altitudinal, latitudinal, and ecotonal transects of environmental diversity. Iodine-131 and $Zn^{65}$ were administered to free-ranging individuals of all three species, and studies were done of isotope turnover rates as an indicator of physiological rates and the relation of retention curves to $O_2$ consumption, food consumption, and temperature. Preliminary results are reported on the radiation dosimetry of chipmunks. (C.H.)

## Metabolism, Tissue Distribution, and Toxicology

**6592** (NP-13454) ASSAY OF STRONTIUM-90 IN HUMAN BONE IN THE UNITED KINGDOM, RESULTS FOR 1962, PART I WITH SOME FURTHER RESULTS FOR 1961. Medical Research Council Monitoring Report Series No. 6. (Gt. Brit. Medical Research Council, London). May 1963. 18p.

Data are presented on the content of $Sr^{90}$ in samples of bone collected in the United Kingdom. Most of the samples were from subjects who died during the first 6 months of 1962. (C.H.)

**6593** (OCD-OS-62-135) MODELS FOR ESTIMATING THE ABSORBED DOSE FROM ASSIMILATION OF RADIONUCLIDES IN BODY ORGANS OF HUMANS. Carl F. Miller and Stephen L. Brown (Stanford Research Inst., Menlo Park, Calif.). May 1963. 122p.

Equations for estimating the absorbed dose from assimilation of radionuclides in the body organs of humans are presented for several assumed conditions of ingestion rates that are considered applicable to the consumption of human foods following contamination by fallout in a nuclear war. The absorbed dose model equations giving the body organ elimination rates are based on the assumption that the elimination rate is proportional to number of atoms in all organs except the gastrointestinal tract. The absorbed dose equations and parameter constants for both young and adult humans are summarized. (auth)

**6594** (TID-19810) THE INFLUENCE OF FOLIAR LEACHING UPON PLANT NUTRITION WITH SPECIAL REFERENCE TO ROOT-UPTAKE, TRANSLOCATION, AND LOSS OF CALCIUM (thesis). Roy Albert Mecklenburg (Cornell Univ., Ithaca, N. Y.). Feb. 1964. Contract AT(30-1)-2598. 131p.

The leaching of fallout fission products from the leaves of plants and the redistribution and storage of fission products in plants are discussed. Data are presented from studies on the leaching of $Ca^{45}$ and $Sr^{89}$ from the leaves of potato plants and accumulation in underground tubers of the foliar leachate. Foliar leaching was also found to accelerate the rate of root uptake and translocation of $Ca^{45}$ misted plants. Mechanisms of nutrient recycling within plants and its role in the redistribution of fallout fission products in plants are discussed. (C.H.)

**6595** (TID-19836) RADIOTRACER STUDIES ON THE MECHANISM OF INSECTICIDAL ACTION. Final Report. John E. Casida (Wisconsin. Univ., Madison). [1963]. Contract AT(11-1)-1187. 13p.

Insecticides or other compounds of possible importance in the mechanism of insecticidal action were labeled with radioisotopes and used in studies of the mechanisms of insecticidal action. Metabolic changes in the labeled compounds were followed in biological systems of interest and the metabolites characterized when possible. An attempt was made to relate the results to the mode of insecticidal action or other types of biological activity. Data were obtained on the persistence and toxic effects of the insecticides in plants where applicable. Results are reported from studies on organophosphate insecticides labeled with $P^{32}$, carbamate insecticides labeled with $C^{14}$, aromatic acids labeled with $C^{14}$, sterol metabolism in insects using cholesterol-$C^{14}$ as a tracer, iodine metabolism in insects using $I^{131}$ as a tracer, and rotenone labeled with $C^{14}$. A list is included of 44 publications resulting from these studies. (C.H.)

**6596** (TID-19842) PROGRESS REPORT [ON ACCUMULATION OF MINERALS]. (Pennsylvania State Coll., State College). Nov. 1963. Contract AT(30-1)-2744. 6p.

The genetic control of metabolism and accumulation of Sr, Ca, K, and Mg in hybrid corn plants was studied in synthetic populations from $F_1$ single crosses of high × low accumulators of each element and $F_2$ and reciprocal back crosses from lines previously shown to accumulate high or low levels of Sr, Ca, Mg, and P. Genotypes that accumulated a high level of these elements as seedlings were found to maintain this genetic difference to maturity. Applications of results in the development of genotypes that accumulate relatively low levels of fallout $Sr^{90}$ are discussed briefly. A list is included of publications resulting from this study. (C.H.)

**6597** (TID-19847) EFFECTS OF PLASMA ON THE ABSORPTION OF ZINC BY MAMMALIAN ERYTHROCYTES. J. P. OKunewick, S. E. Herrick, and T. G. Hennessy (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). [Nov. 18, 1963]. Contract AT(04-1)-Gen-12. 14p.

The effect of plasma on uptake of $Zn^{65}$ by rat red cells was determined by in vitro investigation. It was found that the amount of Zn which the cells would absorb per unit time was inversely proportional to the amount of plasma present in the external medium, indicating inhibition of $Zn^{65}$ uptake by red cells in the presence of plasma. Conversely it was found that previously labeled red cells showed a greater loss of $Zn^{65}$ to a plasma medium than to a saline medium, indicating that the loss of $Zn^{65}$ from red cells is facilitated by the presence of plasma. (auth)

**6598** (TID-19922) RADIOACTIVE ZINC-65 IN MARINE ORGANISMS IN FISHER'S ISLAND SOUND AND ITS ESTUARIES. Final Report, December 1, 1959 through November 30, 1963. Donald M. Skauen (Connecticut. Univ., Noank. Marine Research Lab.). Dec. 13, 1963. Contract AT(30-1)-2487. 51p.

Data are presented on the content of total Zn and $Zn^{65}$ in marine organisms from the Thames River, New Haven Harbor, and Pawcatuck River in Connecticut during 1961, 1962, and 1963. Procedures were developed for the determination of microgram quantities of Zn, $Zn^{65}$, Cu, and Cd in marine organisms and sediments. Emphasis was placed on the uptake of $Zn^{65}$ by oysters (Crassostrea virginica) and limpets (Acmoea t. testudinalis) under natural and laboratory conditions. The effects of environmental factors such as current velocities, temperature, salinity, turbidity, and oxygen content of the water on $Zn^{65}$ uptake were studied. Preliminary results are included from studies of $Zn^{65}$ uptake by organisms attached to limpets. (C.H.)

**6599** (TID-19930) STUDY OF LIGHT ISOTOPES IN LACUSTRINE ENVIRONMENTS. Annual Progress Report. Minze Stuiver (Yale Univ., New Haven). Dec. 1963. Contract AT(30-1)-3204. 47p.

Progress is reported in studies of sulfur metabolism in a fresh water ecosystem. Sulfur-35 was released in Lindsley Pond, North Brandford, Conn., in March. The quantitative S content and $S^{35}$ activity were determined for samples of plants, plankton, fish, and sediments obtained during the next 8 months. (C.H.)

**6600** RADIOAUTOGRAPHIC STUDIES OF BONE MARROW LYMPHOCYTES IN VIVO AND IN DIFFUSION CHAMBER CULTURES. D. G. Osmond and N. B. Everett (Univ. of Bristol, Eng. and Univ. of Seattle). Blood, 23: 1-17(Jan. 1964).

Radioautography with tritiated thymidine was used to examine the turnover rate and origin of small lymphocytes in the bone marrow of the guinea pig. Very few marrow lymphocytes were initially labeled by a single injection of tritiated thymidine, but thereafter the number of labeled lymphocytes rapidly increased to high maximum levels at 3 days. Analysis of the labeling curves and grain counts indicates that the population of marrow lymphocytes is maintained in a dynamic steady state with an average turnover time of 3 days or less. Suspensions of bone marrow cells were isolated from the circulation within intraperitoneal diffusion chambers after short-term labeling with tritiated thymidine in vivo. Although very few small lymphocytes were labeled when introduced into the diffusion chambers, a considerable percentage became labeled during the subsequent culture period. Tritiated thymidine was also administered intravenously whilst excluded from one hind limb by the application of an occlusive compression bandage for 20 min. Very few labeled small lymphocytes were found after 72 hr in the tibial marrow of the initially occluded limb, whereas the normal high percentage was labeled in the control tibial marrow. These experiments do not demonstrate any large-scale influx of small lymphocytes from the blood stream into the marrow parenchyma. They suggest that newly formed small lymphocytes appear in the marrow as a result of the division of locally situated precursor cells, but the mechanism of intramedullary lymphocytopoiesis is uncertain. Transitional cells, intermediate in morphology between blast cells and small lymphocytes, synthesize DNA and are actively proliferative, but they do not appear to account fully for the rate of lymphocyte production. Certain large, undifferentiated labeled cells appeared in the bone marrow as a result of hematogenous migration. Some implications of these findings are discussed. (auth)

**6601** KINETICS OF STEROID EFFECTS ON $Ca^{47}$ DYNAMICS IN DOGS WITH THE ANALOG COMPUTER. [PART] II. Edward R. Garrett, Richard L. Johnson, and Elliott J. Collins (Univ. of Florida, Gainesville). J. Pharm. Sci., 52: 668-78(July 1963).

The effect of adrenal steroids on the distribution of intravenously administered $Ca^{47}$ was studied by use of an analog computer. A distributive model, consistent with the literature, was programmed on the computer and was shown to be in agreement with the fecal and blood serum levels of $Ca^{47}$. Adrenal steroid effects can be assigned to a decrease in the Ca capacity of the metabolic pool with respect to the Ca capacity of the blood and to enhanced transfer of Ca to the gastrointestinal tract. This distributive model was correlated with the empirical equations computer-derived for fitting the $Ca^{47}$ data. Blood levels and fecal excretion of $Ca^{47}$ are enhanced by steroid and depressed on recovery. It was definitely proved that when the quasi equilibria of radioactive Ca among blood, soft tissues, metabolic pool, and contents of the gastrointestinal tract have been achieved, the relatively slow fecal elimination of $Ca^{47}$ at an apparently linear rate is doubled by the steroid administered and relapses to the control values on recovery. The phenomena are consistent with the hypothesis that adrenal steroids not only inhibit the entry of endogenous Ca into the bone and enhance its secretion into the gastrointestinal tract but also promote the resorption of Ca from bone. (auth)

**6602** CONTRIBUTIONS TO THE TOXICOLOGY OF RADIOACTIVE IRON. E. B. Kurlyandskaya. Materialy po Toksikol. Radioaktivn. Veshchestv, Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR, No. 3, 3-11(1962). (In Russian)

Papers are presented based on research carried out in the Radiotoxicology Laboratory, Institute for Industrial Hygiene, of the USSR Academy of Medical Sciences. The studies refer to the chronic effects of $Fe^{59}$, administered in doses close to the maximum permissible concentration, on animal organisms. The problem is of interest because $Fe^{59}$ is widely used in studies on the mobility of Fe in alloys; determination of the hydrodynamics of the cast iron ingots; researches on creep, fatigue, and wear, and in biological studies on the mechanism of hemoglobin exchange in erythrocytes, etc. Knowledge of the effect of $Fe^{59}$ within the animal organism is also important for the study of radiation sickness. The tests usually included oral administration of 1 $\mu$C of $Fe^{59}Cl_3$ per 1 kg of body weight; 10 $\mu$C/kg of $Fe^{59}Cl_3$; 10 $\mu$C/kg of stable $FeCl_3$; the last group represented the physiological control. The metabolism of $Fe^{59}$ tissue doses in the various organs and the whole body, the bioelectric activity of the marrow and of the heart, biochemical and morphological changes, and the threshold of the activity were examined. Analysis of the data indicated that the dose recommended by the ICRP (1959) may cause critical changes in the organism; the dose of $4 \times 10^{-6}$ C/liter for water seems to be excessively high and it is recommended that the MPC should not exceed $1 \times 10^{-8}$ C/liter as was advised in the USSR. (Health Law on Operations with Radioactive Materials and Sources, No. 33366, June 26, 1960) (TTT)

**6603** DISTRIBUTION AND REMOVAL OF VARIOUS COMPOUNDS OF RADIOACTIVE IRON ($Fe^{59}$) IN THE CASE OF THEIR INTRATRACHEAL INTRODUCTION IN WHITE RATS. N. D. Sagaidak. Materialy po Toksikol. Radioaktivn. Veshchestv, Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR, No. 3, 12-18(1962). (In Russian)

The distribution and the removal of various $Fe^{59}$ compounds introduced through the respiratory tract was investigated by administering the insoluble $Fe^{59}$ oxide powder the soluble $Fe^{59}$ citrate to white rats, using the bloodless intratracheal method. The activity of the materials ranged from 18 to 20 $\mu$C for the citrate and 15 to 22 $\mu$C for the oxide. The $\gamma$ activity of the $Fe^{59}$ eliminated in the urine and feces of the animals was determined daily for periods up to 16 days. Some of the animals were killed at various times from 1 hour to 20 days after the introduction of the labeled material. It was found that the main amount of the $Fe^{59}$ citrate is absorbed from the lungs during the first day and is distributed throughout all the organs, accumulating preferentially in the liver, the bone marrow, and the blood. At the end only about 9% remains at the place of the original introduction. On the other hand, nearly all of the $Fe^{59}$ oxide is retained in the lungs and is removed at a slow rate

with the sputum, leaving at the end about 85% of the original amount in the lungs. (TTT)

**6604** RADIATION DOSES IN THE BODY OF RABBITS, TREATED ORALLY EVERY DAY WITH A SOLUTION OF $Fe^{59}Cl_3$; DATA ON THE ACCUMULATION AND REMOVAL OF $Fe^{59}$. G. A. Avrunina. Materialy po Toksikol. Radioaktivn. Veshchestv, Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR, No. 3, 19-34(1962). (In Russian)

In view of the contradictory data in the literature on the dynamics of radioactivity within the organism of animals treated orally with $Fe^{59}Cl_3$, the accumulation of this material in the organs and the doses attributable to it were determined, comparing the results with data obtained with animals subjected to a single intravenous treatment with $Fe^{59}Cl_3$. A previously described method (Materialy po Toksikologii Radioaktivn. Vesh. 2: 14-26; 27-38(1960)) was used for the study. It was found that a single treatment with 2 ml of the $Fe^{59}Cl_3$ solution containing 650 $\mu$C $Fe^{59}$ and 3.3 mg/ml of stable Fe results in the absorption of about 5% the amount introduced; the remainder is removed within a week. The radioactive iron in the bloodstream is removed very slowly from the organism, with a biological half life of at least 100 days. If 2 ml of a $Fe^{59}Cl_3$ solution containing 3 to 7 or 0.3 to 0.7 mg/ml of stable Fe is introduced, the maximum of removal is reached during the first week; the maximum level in the blood is established within 45 to 65 days. After stopping the treatment, the $Fe^{59}$ accumulated in the intestines is removed fast but the activity in the other parts of the body decreases as slowly as in the case of a single parametric introduction. The blood, the spleen, then the liver, lungs, and the parenchymal organs exhibit the highest specific activity. The largest total $\beta$ and $\gamma$ activity was found in the liver and spleen: 1.235 to 1.560 rad/day for animals treated with 10 $\mu$C/kg and 0.33 to 0.173 rad for a day for rabbits treated with 1 $\mu$C/kg. The activity level was higher, the lower the amount of the stable carrier. (TTT)

**6605** SOME PECULIARITIES IN INCLUSION AND DISTRIBUTION OF $P^{32}$ IN THE RABBIT EYE TISSUES. Ts. P. Medvedovskaya and I. A. Likharev (Kiev Inst. of Health Physics and Occupational Disease). Med. Radiol., 8: No. 11, 9-13(Nov. 1963). (In Russian)

Data on levels of inclusion and correlations between the activities of $P^{32}$ in the eye tissue of rabbits at different periods during two months after a single introduction of the isotope are presented. Experiments were staged on 21 rabbits (42 eyes). $P^{32}$ was introduced subcutaneously in a concentration of 250 C/kg. Distribution of the isotope was studied with the radiometric method. The content of the activity in the eye tissues was calculated in $\mu$C and in percentage relation to the total activity of the eyeball. The initial quantity of the isotope in the eye tissues in percentage relation to the originally introduced amount was also calculated, as well as the content of activity in the tissues per 1 g of humid weight in $\mu$C. In single subcutaneous introduction of $P^{32}$ it penetrates into all tissues of the rabbit eye. The eyeball recieves a total of 0.01% of the activity introduced. On the first day the greatest concentration of activity is seen in the eye tissues with a rich vascular network, where intensive metabolic processes take place. The share of the crystalline lens in the included $P^{32}$ is negligible. Later on the named tissues rapidly eliminated $P^{32}$, whereas in the crystalline lens it is only on the 6th day that the maximum activity sets on. In a month and later about 50% of the activity preserved in the eye is concentrated in the crystalline lens. The most radiosensitive sections of the crystalline lens mainly accumulate $P^{32}$. (auth)

**6606** URINARY EXCRETION OF RADIOCALCIUM $^{45}Ca$ BY RATS FOLLOWING WHOLE-BODY IRRADIATION WITH X-RAYS. J. Koloušek and Z. Dienstbier (Charles Univ., Prague). Neoplasma, 10: 507-11(1963).

The influence of x irradiation on the urinary excretion of $Ca^{45}$ by rats after intervals of 6, 12, 24, 48, and 72 hr following its administration was investigated. Radiocalcium was administered in a single dose by intraperitoneal injection in the form of $CaCl_2$ labeled with $Ca^{45}$, in a dose of 0.1 $\mu$C/g of body weight within 15 min after whole-body irradiation with 600 r of x rays. It was revealed that the urinary excretion of $Ca^{45}$ in controls as well as in rats irradiated had two peaks at about the sixth and 48th hr after administration. In irradiated animals these maximum values are, however, substantially lower as compared with controls. Thus in rats in the course of 48 hr after irradiation a decrease in the excretion of $Ca^{45}$ occurred which provides evidence of the fact that during this period radiocalcium is utilized to a greater extent. (auth)

**6607** DNA SEGREGATION IN ESCHERICHIA COLI: OBSERVATIONS BY MEANS OF TRITIATED THYMIDINE DECAY. Stanley Person and Mary Osborn (Pennsylvania State Univ., University Park). Science, 143: 44-6(Jan. 3, 1964).

Escherichia coli, strain 15T-L-, inactivation by $H^3$-thymidine decay was used in a study of DNA segregation. Two characteristics of the inactivation curves due to $H^3$-thymidine decay, the initial slope and stable fraction, enable the mode of segregation to be defined. The results suggest that the segregation pattern is consistent with a semiconservative model of DNA replication. The data on the stable fraction indicate that the DNA of strain 15T-L- under experimental conditions, may be organized into one duplex structure. Since colony-forming ability was used as the means of assay, it is possible to compare these experiments with those in which DNA segregation is examined on a structural basis. (auth)

**6608** CHARACTERISTICS OF THE STATE OF THE RADIOACTIVE ISOTOPES $^{89}Sr$, $^{91}Y$, AND $^{144}Ce$ IN THE BLOOD. L. M. Razbitnaya and V. S. Balabukha. p.125-34 of "Chemical Protection of the Body Against Ionizing Radiation." New York, The Macmillan Company, 1963.

The form in which any radioactive element is found in the blood and the form in which it is eliminated from the body are of importance in an analysis of its behavior in the body and in determining the effectiveness of synthetic preparations for accelerating the elimination of the element from the body. Results are reported from a study of the behavior of $Sr^{89}$, $Sr^{90}$, $Y^{91}$, and $Ce^{144}$ in the blood. The electromigration of the isotopes in solutions of organic acid was compared with the electrophoresis of blood serum containing the isotope. Results indicate that radioactive isotopes of Sr in the blood serum are not combined with any organic acids in noticeable amounts but are found in the form of a cation or bound very unstably with molecules of protein. No stable chemical binding was observed between the radioactive isotopes of Y and Ce and the proteins of the blood serum. It was concluded they are in the form of colloids or pseudocolloids. (C.H.)

**6609** EFFECT OF COMPLEXING AGENTS ON THE CHARACTER OF THE BINDING OF RADIOISOTOPES IN THE BLOOD. L. M. Razbitnaya and V. S. Balabukha. p.135-40 of "Chemical Protection of the Body Against Ionizing Radiation." New York, The Macmillan Company, 1963.

Possible changes in the character of the binding of radioisotopes in the blood and bone tissue during the

action of complexing agents are discussed. Results are presented from a study of the state of $Y^{91}$ and $Ce^{144}$ in the blood during the action of ethylenediaminetetraacetic acid (EDTA), cyclohexanediaminetetraacetic acid (CDTA), and cyclopentanediaminetetraacetic acid (CPDTA). The elements are characterized by a strong tendency to form complexes and are in a colloidal state at the pH of the blood, but their metabolic activity in the body differs. Results indicate that $Y^{91}$ in the blood forms stable complex compounds with the complexing agents used, whereas $Ce^{144}$ formed less stable complex compounds that decomposed when acidity was increased. (C.H.)

**6610** CHARACTER AND STABILITY OF THE BINDING OF $^{91}Y$ IN BONE TISSUE. N. O. Razumovskii, O. L. Torchinskaya, and V. S. Balabukha. p.141-6 of "Chemical Protection of the Body Against Ionizing Radiation." New York, The Macmillan Company, 1963.

The content of $Y^{91}$ in the skeleton was found to remain more or less constant while the radioactivity of the soft tissues decreased with time. Results are reported from an analysis of rabbit bones of the amounts of injected $Y^{91}$ in different fractions of bone. Results showed that over 90% of the $Y^{91}$ in bone was deposited in the collagen fraction and was bound firmly in the bone tissue. A maximum of 21 to 28% of $Y^{91}$ was removed from bone in chromatographic columns by the complexing agents Ca-EDTA and Ca-CDTA. (C.H.)

**6611** ANALYSIS OF THE EFFECTIVENESS OF COMPLEXING AGENTS WHICH ACCELERATE THE ELIMINATION OF RADIOACTIVE ISOTOPES FROM THE BODY. G. E. Fradkin and V. F. Ushakova. p.147-62 of "Chemical Protection of the Body Against Ionizing Radiation." New York, The Macmillan Company, 1963.

The effectiveness of a number of chelating agents in accelerating the elimination of $Y^{91}$ and $Pu^{239}$ was studied in rats. The stability in vivo of complexes of $Y^{91}$ with nitrilotriacetic acid (NTA), ethylenediaminetetraacetic acid (EDTA), and cyclohexanediaminetetraacetic acid (CDTA) and of complexes of $Pu^{239}$ with EDTA and cyclopentanediaminetetraacetic acid (CPDTA) was studied. The effects of method and time of administration of the chelating agent, and of the administration of complexes of the isotopes and chelating agents were also studied. Factors affecting the effectiveness of complexing agents as a means of accelerating the elimination of $Y^{91}$ and $Pu^{239}$ from the body are discussed. (C.H.)

## Radiation Effects

**6612** (ABCC-16-62) ADULT HEALTH STUDY. REVIEW OF SUBSTUDIES, JUNE 1962, HIROSHIMA AND NAGASAKI. Stuart C. Finch (Atomic Bomb Casualty Commission, Hiroshima). Contract AT-49-1-GEN-72. 67p.

Data are summarized from a series of studies to determine the late effects of radiation in adult populations of Nagasaki and Hiroshima. Results are reported from studies on skin aging, hair greying, cardiovascular findings, neuromuscular response, antibody levels, ocular aging, auditory aging, and miscellaneous aging characteristics in persons exposed to radiation from the atomic bombs as adults; growth and development studies on exposed persons born between 1935 and 1945; the incidence of neoplasms in the exposed populations; possible genetic effects of radiation in selected groups; the incidence of tuberculosis and other infectious diseases in exposed populations; hematological studies; metabolic studies, and other related studies in exposed persons and their offspring. Possible future programs are discussed. (C.H.)

**6613** (ABCC-18-62) FERTILITY STUDY. HIROSHIMA AND NAGASAKI PROVISIONAL RESEARCH PLAN. Hisao Sawada and Stuart C. Finch (Atomic Bomb Casualty Commission, Hiroshima). [nd]. Contract AT-40-1-GEN-72. 24p.

A proposed program is described for a fertility study on populations of Hiroshima and Nagasaki. An attempt will be made to determine whether exposure of either or both parents to the ionizing radiation from atomic bombs approximately 16 yr previously resulted in reduced fertility defined as a reduction in the number of conceptions as well as the actual number of offspring. The study will also attempt to determine whether presence in either city at the time of the bombings resulted in voluntary restrictions in family size because of economic disruption or fear of radiation effects. (C.H.)

**6614** (BLG-194) PROLONGATION PAR IRRADIATION DE LA DUREE DE CONSERVATION DE LEGUMES BLANCHIS. (Prolongation by Irradiation of Preservation Time of Blanched Vegetables). M. de Proost (Brussels. Centre d'Etude de l'Energie Nucléaire); J. Seeger, and L. Bolly (Belgium. Institut National pour l'Amelioration des Conserves de Legumes). May 1963. 23p.

Blanched vegetables were irradiated with doses of 0.1, 0.25, and 0.5 Mrad and stored at temperatures of 0 and 5°C. In these vegetables the reduction of the initial microbial population after irradiation and the microbial development during storage was studied. With a dose of 0.1 to 0.5 Mrad the storage life of blanched vegetables was increased considerably. It varied with the radiation dose and the type of vegetable. The storage life at 5°C was 3 to 30 days, and at 0°C, 16 to 90 days. The variability of the bacterial counts was studied. (auth)

**6615** (RTD-TDR-63-3027) EFFECTS OF COBALT-60 IRRADIATION TO THE REGION OF THE BRAIN OF THE BURRO. HEMATOLOGICAL RESPONSES FOLLOWING EXPOSURES OF 200 r AND 600 r. Ronald E. Engel, Francis A. Spurrell, and Sadie Cartwright (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Nov. 1963. 39p.

Twenty-two adult male burros were exposed to $Co^{60}$ radiation to the head only. Six out of seven receiving 600 r died. In contrast, six out of six burros receiving 200 r survived. Acute hematological changes observed in the 600-r irradiated group were in close agreement with early acute blood changes observed in whole-body irradiation of burros and other mammalian species. Early hematological responses were valuable prognostic aids for determining degree of brain and/or pituitary injury. (auth)

**6616** (SAM-TDR-63-55) LATENT EFFECTS OF CHRONIC IRRADIATION ON LONGEVITY AND THE PERIPHERAL BLOOD ELEMENTS OF THE MONKEY, MACACA MULATTA. Donald R. Anderson (School of Aerospace Medicine, Brooks AFB, Tex.). Sept. 1963. 6p. (AD-423076)

Long-term results are reported from a study of the effects of chronic exposure to mixed gamma–neutron radiation in monkeys. Thirty-five young adult male Macaca mulatta were exposed to doses ranging from 77 to 614 rep during 4 exposures of 16 hr each with a 4-day recovery time between exposures or 20 exposures of like duration with a 12-day recovery time between exposures. Observations over a period of several years post-irradiation showed that the hematopoietic system returned to essentially normal conditions and showed no long-term effects due to irradiation. No change in longevity was observed to result from the radiation exposure. (C.H.)

**6617** (TID-19843) RADIOLOGICAL STUDY OF SALMONELLA TRANSDUCTION. Final Report, Septem-

ber 15, 1960–September 14, 1963. Harold H. Plough (Amherst Coll., Mass.). Nov. 12, 1963. Contract AT (30-1)-2452. 13p.

The mechanism of transduction by bacteriophage in Salmonella typhimurium was studied by subjecting the cells to $\gamma$ radiation at critical points in the formation of transducing phage. It was concluded that the frequency of transduction for any one locus in synchronized cells is determined by the stage reached in sequential replication of the cell DNA strand at the moment when replicating phage DNA becomes available. Phage DNA replication proceeds at a more rapid rate than cell DNA, and it may incorporate a fragment of the cell DNA at the point where replication is occurring. The data indicate that the order of transduction in synchronized division is the linear order of the loci in the DNA strand. Strain differences were observed in both phage and cell. (C.H.)

**6618** (TID-19899) THE INVESTIGATION OF THE GENETIC STRUCTURE OF POPULATIONS. Bruce Wallace (Cornell Univ., Ithaca, N. Y.). Dec. 10, 1963. Contract AT(30-1)-2139. 27p.

Results are summarized from studies on radioinduced and spontaneous mutations in populations of Drosophila melanogaster. Data are included from a study of the viability effects of spontaneous mutations, the rate at which second chromosome lethals arise by spontaneous mutation, and the effect of these lethals on the viability of heterozygous carriers in populations of Drosophila melanogaster. A list is included of papers published as a result of these studies. (C.H.)

**6619** (TID-19920) A STUDY OF THE COMPARATIVE EFFECTS OF IONIZING RADIATION AND AGING ON THE MAMMALIAN LENS OF THE EYE. Final Scientific Report. W. T. Ham, Jr., Walter J. Geeraets, F. H. Schmidt, R. C. Williams, Harold A. Mueller, R. S. Ruffin, Edward R. Berry, Malcolm E. Turner, and Dupont Guerry, III (Medical Coll. of Virginia, Richmond). [196?]. Contract AT(40-1)-2452. 72p.

The eyes of 120 rabbits, 8 to 12 weeks of age, received radiation doses of 0, 200, 600, 1000 r from a 1-Mev x-ray machine. The x-ray dose was delivered either to the whole eye or to a portion of the eye. All animals received a biomicroscopic examination before irradiation and at 6-month intervals thereafter until death or sacrifice intervened. The colony of 120 rabbits was divided into 6 groups according to a balanced incomplete block arrangement designed statistically for maximum information. Animals were sacrificed, 4 at a time, at 6-month intervals until each of the 6 groups was depleted. The relation between ionizing radiation exposure and aging is given in terms of physical data involving the mass, density, hardness, and light transmission of the rabbit lens, and in terms of the clinical findings. The data indicate that changes in the physical properties of the lens seem dependent primarily upon age, whereas clinical findings seem most affected by radiation dose and method of exposure. Chemical changes in the lens proteins were detected after exposure to 25 r. In general, these data do not support the hypothesis that there is a well-defined relation between radiation damage and aging in the rabbit lens. (auth)

**6620** (TID-19929) RADIOAUTOGRAPHIC, HISTOCHEMICAL AND BIOCHEMICAL STUDIES OF THE EFFECTS OF IRRADIATION IN CARTILAGE AND BONE. Progress Report, January 1, 1963–December 1, 1963. Albert Hirschman (New York. State Univ., New York. Downstate Medical Center). Contract AT(30-1)-2960. 15p.

Progress is reported in studies of the effects of radiation on the vascular supply and protein synthesis and antibody production in cartilage and bone of young rats. A method is described for the preparation and staining of cartilage for the microscopic demonstration of mucoproteins. Results are reported from a study in which $Ca^{47}$ and $I^{131}$-serum albumin were used as tracers to determine the effects of 4000 r x radiation on the vascular volume and rate of blood flow in bone; studies on the properties of mucoproteins and mucopolysaccharides in epiphyseal cartilage; and studies of antibody formation in cartilage. (C.H.)

**6621** (UCSF-23) RADIOLOGICAL LABORATORY ANNUAL PROGRESS REPORT FOR PERIOD ENDING SEPTEMBER 30, 1963. (California. Univ., San Francisco. School of Medicine. Radiological Lab.). Nov. 1963. Contract AT-11-1-GEN-10. 56p.

Results are summarized for 388 patients with various types of tumors treated with 70-Mev x rays from a synchrotron. Best results were obtained in the treatment of carcinoma of the urinary bladder, carcinoma of the uterus, and intracranial tumors. Results are reported from studies on the effects of x radiation on the life span of hamsters, intercapillary glomerulosclerosis in the kidneys of mice, the life span and tumor incidence of the progeny from mice whose spermatogonia were exposed to doses of 248 to 720 rads, radioinduced mutations in mice, and histoincompatibility of skin grafts in radioinduced mouse mutants. A list is included of publications during the period covered by this report. (C.H.)

**6622** (USNRDL-TR-682) EEG DESYNCHRONIZATION BY X RAYS IN RATS WITH TRANSECTED SPINAL CORDS. G. P. Cooper and D. J. Kimeldorf (Naval Radiological Defense Lab., San Francisco). Oct. 14, 1963. 13p. (AD-424176)

Rats with transected spinal cords showed EEG desynchronization and behavioral arousal to whole-body or head-only x irradiation at dose rates between 0.5 and 1.5 r/sec. No arousal or EEG desynchronization occurred when only the body of a spinal transected animal was exposed. Results indicate that neither the circulatory system nor the vagi are essential to the arousal reaction to x irradiation. (auth)

**6623** (AEC-tr-6234) THE FREQUENCY OF MYELOID LEUKOSES IN MICE DEPENDING ON THE DOSE OF EXTERNAL GAMMA RADIATION. R. V. Smirnov. Translated for Oak Ridge National Lab., Tenn., from Vopr. Onkol., 8: No. 10, 59-64(1962). 12p.

A single irradiation of white non-bred mice from an external source of $\gamma$ radiation in doses of 100, 200, 400, 600, and 800 r resulted in an increase in the frequency of myeloid leukoses up to a dose of 600 r. The nature of the relation between the dose at which the animals were irradiated and the frequency of leukoses was exponential in the interval from the control to a dose of 600 r. The latent period of leukoses became shorter on increasing the radiation dose. The blood picture in the pre-leukosis period was characterized by the appearance of a small number of immature forms in blood development; however, the number of leukocytes remained within the normal range or exceeded it slightly. On the basis of the relation between the radiation dose and the frequency of leukoses, it was concluded that this process belongs in the category of phenomena having no threshold. (auth)

**6624** GLYCOGEN CHANGES IN X-IRRADIATED RAT BRAIN. J. Miquel, L. Klatzo, D. B. Menzel, and W. Haymaker (Ames Research Center, Moffett Field, Calif.; National Inst. of Health, Bethesda, Md.; and Univ. of California, Berkeley). Acta Neuropathol., 2: 482-90(1963).

X irradiation of the head of rats resulted in the accumulation of histochemically demonstrable PAS-positive granules in the brain, which were identified as glycogen. The glycogen granules were confined predominantly to the neuroglial cells; they did not appear in neurons. The amount of glycogen granules was approximately proportional to the dose administered. Although such changes are known to occur under conditions of ionizing particle radiation, this is the first demonstration that they appear following x irradiation. Quantitative chemical analysis of the brains by the glucose oxydase method demonstrated an increase of glycogen of approximately 40%, 24 hr after exposure to 3,000 r. The biochemical change responsible for the glycogen accumulation may consist in an impairment of the enzymes mediating the incorporation and release of glucose from glycogen. (auth)

**6625** A HISTOLOGIC STUDY OF THE FOREIGN SPLEEN REACTION IN SUBLETHALLY IRRADIATED F1 HYBRID MICE. G. E. Cosgrove, A. C. Upton, and C. C. Congdon (Oak Ridge National Lab., Tenn.). Am. J. Pathol., 40: 455-67(Apr. 1962).

Tissues of sublethally irradiated hybrid mice injected with parental strain spleen cells after 500 r whole-body x irradiation underwent a spectrum of changes varying in severity and depending on the strain combination. Mortality was similarly strain-dependent. The lesions were most striking in lymphoid structures, such as the lymph nodes, splenic white pulp, and Peyer's patches of the intestine. They consisted of marked hyperplasia of stromal reticular cells, with obliteration of the normal architecture and apparent interference with regeneration or repopulation following irradiation. This lesion often progressed to necrosis, ending in scarring and fibrosis, although in late survivors normal architecture tended to be restored. The thymic lymphoid tissues did not take part in the hyperplastic reaction. Before peak intensity of these granulomatous changes, there was regeneration of blood-forming cells in the bone marrow, thymus and splenic red pulp. After 2 to 3 weeks, however, secondary atrophy frequently occurred at these sites, followed again in about 1 week by regeneration in survivors. The periportal areas of the liver often showed leukocytic infiltration at the height of the reaction. No constant change was noted in most other tissues. (auth)

**6626** AN ANOMALOUS LYMPHOCYTE: POSSIBLY DIAGNOSTIC FOR EXPOSURE TO IONIZING RADIATIONS OR RADIOMIMETIC AGENTS. Roberts Rugh (Columbia Univ., New York). Am. J. Roentgenol., Radium Therapy Nucl. Med., 91: 192-201(Jan. 1964).

The bi- and trinucleated condition was found regularly in control (unirradiated) $CF_1$ female mice to the extent of 2 to 4% of all lymphocytes. Cytoplasmic inclusions, which are believed to be fragments of the nucleus (nuclear satellites), were never seen in over 22,000 normal mouse lymphocytes examined. They have never been reported in normal human blood. At 2 weeks after whole-body exposure to x rays, there was no evidence of any significant increase in the multinucleated lymphocytes, even in exposures up to 500 r. The lymphocyte cytoplasmic inclusions (nuclear satellites) were found in the peripheral blood after all levels of exposure from 100 to 500 r, in frequencies from 0.15 to 1.16%, and in higher incidence in lymphocytes in lymph nodes. There was a definite increment in the incidence of these inclusion bodies when exposure levels were increased. In a daily study of the peripheral blood of x-irradiated mice (200 and 400 r) for 10 weeks, it was found that the cytoplasmic nuclear satellites in lymphocytes were seen regularly beginning at 1 day. The peak incidence occurred between 2 and 4 weeks postirradiation, but they were also found as early as 12 hr and after only 10 r exposure. The inclusion bodies appeared to be fragments of the nucleus (nuclear satellites), their structure and straining proclivities being the same. Karyorrhexis is a situation known to other somatic cells following high levels of x irradiation and the lymphocytes have long been recognized as particularly radiosensitive. The stress of continued low temperature (10°C) for 3 months did not produce these inclusion bodies in lymphocytes in mice. While it is possible that other forms of stress might produce such bodies, ionizing radiations and radiomimetic agents (nitrogen mustard or chlorambucil) appear to be particularly effective in causing karyorrhexis. Lymphocyte cytoplasmic inclusions, which seem to be nuclear fragments or satellites (karyorrhexis), appeared in the peripheral blood of mice, rats, fetal and adult monkeys, and in several humans with malignant diseases after treatment with a radiomimetic agent and/or x irradiation. While the incidence of these anomalous cells was not high, the fact that they were never seen in normal mouse, rat or monkey blood and have never been described in normal human blood suggests that their presence may be an accessory fact in diagnosing a prior possible exposure to ionizing radiations. (auth)

**6627** ON THE QUESTION OF THE SMALLEST BIOLOGICALLY EFFECTIVE DOSE. COLONY FORMATION ABILITY OF E. COLI B AFTER X IRRADIATION. M. Kraft (Max-Planck-Institut für Biophysik, Frankfurt am Main). Biophysik, 1: 154-66(1963). (In German)

In the x irradiation of E. coli B under different experimental conditions, no evidence for the existence of a "smallest biologically effective dose" could be found. In all investigated cases the dose-effect curve proceeded absolutely exponentially up to about 60 r, for a measurement accuracy of $2\sigma = \pm 3\%$. Variations from results of other authors are discussed. (tr-auth)

**6628** EFFECTS OF HEAVY HIGH ENERGY CHARGED PARTICLES. I. LITERATURE REVIEW OF EFFECTS OF PROTONS, DEUTERONS, AND $\alpha$-PARTICLES IN MAMMALS WITH A THEORETICAL CONSIDERATION OF THE NEGATIVE $\pi$-MESON. Stuart W. Lippincott, William H. Moore, Jr., John E. Jesseph, Wenceslao G. Calvo, and Lee E. Farr (Brookhaven National Lab., Upton, N. Y.; Wake Forest Coll., Winston Salem, N. C.; and M. D. Anderson Hospital and Tumor Inst., Houston, Tex.). Arch. Pathol., 76: 497-526 (Nov. 1963). (BNL-6980)

A review is presented on the effects of protons, deuterons, and particles in mammals with a theoretical consideration of the negative $\pi$ meson. An introductory section is included concerning the physical properties and dosimetric considerations of the particles in order to clarify the pertinent facts essential to an understanding of the nature of the transfer, release, and absorption of energy during the traversal of living mammalian tissues by charged particles. 54 references are included. (P.C.H.)

**6629** SOME DATA ON MECHANISM OF LEUKOPENIA AND LEUKOCYTOSIS FOLLOWING IRRADIATION. Julia Gidali and Imre Feher (National Research Inst. for Radiobiology and Radiohygiene, Budapest). Blood, 23: 27-37 (Jan. 1964).

In rabbits irradiated with 150 to 600 r, granulocytosis is preceded by a prompt significant granulocytopenia developing 5 to 15 min after irradiation but persisting for a short time. The plasma taken at the minimum of the initial granulocytopenia produced a similar two-phase reaction when

injected into normal animals: a promptly developing significant granulocytopenia persisting for a short period followed by prolonged granulocytosis. Prolonged thrombocytopenia might be induced by the very same plasma. The above-mentioned reactions may be reproduced satisfactorily with the administration of dilute starch solutions. On the basis of the results obtained, it seems likely that the agent demonstrable in the plasma after irradiation, and influencing the level of circulating granulocytes and thrombocytes, is not a toxin (leukotoxin) but a substance that may be formed following physiologic stimuli as well. (auth)

**6630** BONE TUMOUR PRODUCTION IN MICE BY STRONTIUM-90: FURTHER EXPERIMENTAL SUPPORT FOR A TWO-EVENT HYPOTHESIS. R. H. Mole (Medical Research Council Radiobiological Research Unit, Harwell, Berks, Eng.). Brit. J. Cancer, 17: 524-31(Sept. 1963).

Data from experiments on bone tumor production by $Sr^{90}$ in mice are analyzed to show that the rate of appearance of tumors with time after administration is proportional to the square of the number of radioactive disintegrations within the skeleton in the time interval before the tumor is induced. (auth)

**6631** THE EFFECT OF γ-IRRADIATION ON THE AMOUNT OF 5-HYDROXYTRYPTAMINE IN THE GUT AND SPLEEN IN THE EARLY PHASE AFTER IRRADIATION. V. Varagić, M. Krstić, S. Stepanović, and S. Hajduković (Medical Faculty, Belgrad and Inst. of Nuclear Science "Boris Kidrich", Belgrad). Experientia, 19: 647-8(1963).

The effects of gamma irradiation and of cysteamine protection on the amount of 5-hydroxytryptamine (5-HT) in the gut and the spleen were studied. Male rats received 900 r, were killed, and a piece of the intestine and the whole spleen were taken out and extracted. Results indicated that the irradiation did not produce a significant change in the amount of 5-HT present 24 and 48 hr after irradiation. Cysteamine protection was found to reduce significantly the amount of 5-HT in the spleen. (M.C.G.)

**6632** EXCRETION OF ELECTROLYTES BY ADRENALECTOMIZED AND CONTROL RATS GIVEN A MIDLETHAL DOSE OF TOTAL BODY X-IRRADIATION. E. Irene Pentz (Chicago Wesley Memorial Hospital). Exptl. Cell Res., 32: 170-4(Oct. 1963). (TID-18928)

Animals without adrenal glands were shown to excrete an excess of K immediately following a midlethal dose of whole-body irradiation. It is difficult to attribute such an enormous immediate loss of K entirely to tissue destruction, since this represents an increased excretion of approximately one-third their control output for a six-hour period. It is also difficult not to conclude that some kidney changes must occur either during or very rapidly following irradiation of these animals. Since adrenalectomized rats do not exhibit increased polyuria following whole-body x irradiation but do exhibit the increased K excretion, the two phenomena must be considered to be independent. (auth)

**6633** EFFECTS OF TEMPERATURE AND X-RAY IRRADIATION ON INTRINSIC GROWTH RATE IN POPULATIONS OF DROSOPHILA PSEUDOOBSCURA. A. O. Tantawy (Univ. of Alexandria, Egypt). Genetica, 34: 34-45 (1963).

An experiment was designed using populations of Drosophila pseudoobscura with different gene arrangements on the third chromosome, to study the effects of various temperatures and different dosages of radiation on the innate capacity for increase. The innate capacity for increase was found to increase with temperature and decrease with higher radiation dosages. The mean generation length showed a decline with both treatments with a greater decrease in the former treatments. Net reproductive rate showed a decrease in both cases while the finite rate of increase (λ) showed an increase in the temperature experiment and a decrease in the radiation experiment. Percentage contribution of each age group to the rate of multiplication per generation depended on temperature and dosages of radiation as well as the genetic background of the population. (auth)

**6634** AN INDUCED MULTIPLE CARPEL MUTATION IN BREAD WHEAT. C. R. Bhatia and M. S. Swaminathan (Indian Agricultural Research Inst., New Delhi, India). Genetica, 34: 58-65(1963).

Mutants showing partial or complete transformation of stamens into carpels or carpel-like structures were recorded in $M_2$ progenies, following irradiation of dry seeds with 16 R rads of x rays and following treatment with β particles from $S^{35}$, in bread wheat variety H 167. The multiple carpel mutation has a low and variable expression. It appears to be recessive to normal. Seed setting was poor in bagged spikes of the mutant plants but reasonably good seed set was obtained under conditions of open pollination. Not more than one functional carpel was found in any flower and this was always the normal carpel. (auth)

**6635** ON THE NATURE OF MICRONECROTIC FOCI IN HEMOPOIETIC ORGANS OF IRRADIATED ANIMALS. M. N. Meissel and V. M. Manteifel (Inst. of Radiation and Physico-Chemical Biology, Moscow). Izv. Akad. Nauk SSSR, Ser. Biol., No. 6, 871-9(Nov.-Dec. 1963). (In Russian)

Rapid air drying of intravitam and supravitam stained fluorochromed smears from tissues and organs (among them— hemopoietic organs) enables a variety of luminescence peculiarities of both normal and pathologically altered cells to be preserved. By means of this procedure, micronecrotic foci (at least part of them) arising in the hemopoietic organs of irradiated animals were identified with macrophages that phagocytize cells and their fragments. The increase and decrease of micronecrotic foci after irradiation of animals illustrates the dynamics of mobilization of macrophages and of activation of their phagocytic function. Formations close to the radiation caused micronecrotic foci that are like phagocytizing macrophages and can be reproduced experimentally by administering damaged lymphocytes to the spleen and lymphatic nodes of normal animals. Similar results were obtained by local mechanical injury of the spleen (needle prick). The changes disclosed in the pattern of inherent ultraviolet luminescence of macrophages and of phagocytized cells reflect various stages of intracellular digestion of these cells and are presumably linked with activation and increased synthesis of hydrolytic enzymes. Luminescent microscopy both in the visible and ultraviolet range of the spectrum proved a simple, convenient but precise tool for studying phagocytosis and intracellular digestion. (P.C.H.)

**6636** PSITTACOSIS-INFECTED CELL SYSTEM FOR STUDIES ON RADIATION DAMAGE. Nehama Sharon, Morris Pollard, and W. R. Klemm (Univ. of Notre Dame, Ind.). J. Bacteriol., 86: 1139-44(Dec. 1963).

The unique replication pattern of the agent of psittacosis in cells provides a means for studying biological effects of radiation and the influence of radioprotective drugs on this cell virus system. Intracellular psittacosis virus (strain TT) showed a distinctive sensitivity to x irradiation at 3 to 9 hr after onset of infection. This sensitivity to x rays disappeared later in the replication cycle when the virus-

orientated ribonucleic acid matrix appeared in the infected cell. The effect of x rays was on the early stages of the virus, since evidence of subsequent developmental stages could not be observed. During the sensitive stage, the amount of surviving virus was related to the dose of x rays. Irradiation caused an irreversible reaction on sensitive virus. The progeny of surviving virus were unaltered in susceptibility to x rays. Addition of glutathione to infected cultures before irradiation increased the amount of surviving virus. Cysteine · HCl and heat-inactivated calf serum were only protective to the virus. Cysteamine was toxic to the cells, and low concentrations gave no protection. Other compounds tested failed to protect the viral agent against the effect of x rays. (auth)

**6637** NEOPLASMS IN CHILDREN TREATED WITH X RAYS FOR THYMIC ENLARGEMENT. I. NEOPLASMS AND MORTALITY. James W. Pifer, Edward T. Toyooka, Robert W. Murray, Wendell R. Ames, and Louis H. Hempelmann (Univ. of Rochester, N. Y.). J. Natl. Cancer Inst., 31: 1333-56(Dec. 1963).

Demographic information and radiation factors are presented for 2,809 children treated with x rays for thymic enlargement in an upstate New York county between 1926 and 1957. Approximately half the children had been studied previously. The remainder were new cases. Information regarding the health and mortality of the treated children of both series was collected by mail survey in 1959 and 60. Procedures for tracing families and other methodological aspects of the survey, including the design of the questionnaire and response rates, are described. Radiation dosage factors used in treatment are believed to be accurate. Almost all the children were irradiated before the age of 6 months. Many of the older children were given relatively high doses of x rays to large areas that often involved the posterior as well as the anterior aspects of the chest. The younger children were usually given lower doses of x rays to relatively small anterior areas. The 1,451 children previously studied had a high incidence of tumors, particularly leukemia and thyroid neoplasms. The present survey shows that these children continued to develop tumors at a higher rate than that of their untreated siblings and higher than that expected in a comparable group from the general population. Thyroid adenomas and carcinomas comprise about one half, and osteochondromas, about one sixth of all tumors. No new cases of leukemia have occurred since the previous survey. Several cases of salivary gland tumors and neurilemmomas, which are very rare neoplasms in children and young adults, were observed. Data on mortality of treated children and their siblings in both series are difficult to evaluate. The moderate excess of deaths in children of series I after the first year of life was attributed to 6 cases of leukemia. (auth)

**6638** NEOPLASMS IN CHILDREN TREATED WITH X RAYS FOR THYMIC ENLARGEMENT. II. TUMOR INCIDENCE AS A FUNCTION OF RADIATION FACTORS. Edward T. Toyooka, James W. Pifer, S. Lee Crump, Arthur M. Dutton, and Louis H. Hempelmann (Univ. of Rochester, N. Y.). J. Natl. Cancer Inst., 31: 1357-77 (Dec. 1963).

The tumor incidence in 2,809 children treated with x rays for thymic enlargement was analyzed in terms of the dose and other radiation factors. Because of the small number of specific types of neoplasms, the tumors were combined for analysis into three categories: all thyroid tumors, other tumors inside the directly treated tissues, and tumors outside the directly treated tissues. A striking increase of all neoplasms, less marked for tumors outside the treated tissues, was noted as the children grew older. This complicated the analysis because the older children usually received higher doses through larger ports, frequently placed posteriorly as well as anteriorly. When the age relation was corrected by the use of cohort-analysis, a given air dose administered half anteriorly and half posteriorly to the chest was associated with a significantly higher tumor incidence than that observed when the same total dose was given only anteriorly. The incidence of thyroid tumors was considerably higher with the former technique. Irradiation both anteriorly and posteriorly was also associated with a strong tendency of the tumors to cluster in primary irradiated tissues, a phenomenon not so pronounced when anterior irradiation alone was used. Attempts to demonstrate a dose dependence for the major treatment groups, i.e., combined anterior and posterior, and anterior treatments were unsuccessful. The failure to show a dose response was attributed to the small number of neoplasms, rather than to definite evidence of an absense of such an effect. The clustering of tumors in the directly irradiated tissues and the apparent effect of port arrangement on tumor incidence constitute strong circumstantial evidence favoring radiation exposure as an etiologic factor in tumor production. The apparent effectiveness of combined anterior and posterior irradiation in inducing tumors could be due to exposure of certain tissues in the head and neck with this port arrangement. These tissues, including the pituitary gland, were not likely to be exposed when anterior ports alone were used. Possibly the 2-week interval between treatments of the group of children with the highest tumor incidence also augmented the oncogenic action of the radiation exposure. (auth)

**6639** NEOPLASMS IN CHILDREN TREATED WITH X RAYS FOR THYMIC ENLARGEMENT. III. CLINICAL DESCRIPTION OF CASES. Edward T. Toyooka, James W. Pifer, and Louis H. Hempelmann (Univ. of Rochester, N. Y.). J. Natl. Cancer Inst., 31: 1379-1405(Dec. 1963).

Detailed clinical and pathological descriptions of 69 neoplasms occurring in a group of 2,809 children treated with x rays for thymic enlargement in infancy are presented. Complete radiation treatment factors are also given. Thyroid neoplasms were emphasized as they comprised 43% of the tumors. (auth)

**6640** STUDIES ON BONE MARROW FUNCTION TEST PERFORMED IN 1962 ON ATOM-BOMBED SURVIVORS RESIDING IN FUKUOKA SAGA AND YAMAGUCHI PREFECTURES. Tando Misao (Kyushu Univ., Fukuoka), Kenichi Hattori, Hajime Fukuta, et al. Kyushu J. Med. Sci., 14: 99-102(Apr. 1963).

As a follow-up study, the bone marrow function test by the use of cobalt-chlorophyllin on 50 survivors of atomic bombing was carried out in 1962. The average values of the peripheral blood on the 50 survivors examined were somewhat low in general, as this was the basis for their selection for this study. Study on the bone marrow function test on the 50 survivors revealed that there were 38 normal cases (76%) and 12 hypofunctional cases (24%). The average values were 1.94 ± 0.916 in increase ratio and +7.45 ± 7.972 in increase index, respectively. Both data showed no remarkable change as compared with normal values, but a significant increase compared with data obtained in 1961: 1.46 ± 0.536 and +2.16 ± 7.090, respectively. Follow-up study on 7 subjects studied originally in 1961 revealed that 3 have recovered to a normal value, 3 remained unchanged within the normal range, and 1 remained unchanged at the lower limits of normal. Hematological study, although in limited number, also indicates that most

of the 7 subjects have had year by year a trend toward a normal peripheral blood picture. The data seem to offer good news to survivors of atomic bombing, but it should be stressed that the still higher incidence of low value in the test in these survivors needs a further, careful, follow-up study. (auth)

**6641** TEST OF A NEW ANTIDIARRHEIC DRUG (R. 1132) IN DIARRHEA FOLLOWING ABDOMINAL AND PELVIC IRRADIATIONS. H. Pourquier, J. Belotte, and J. L. Lamarque (Travail du Centre Anticancereux Regional, Montpellier, France). J. Radiol., Electrol. Med. Nucl., 44: 647-8(Oct. 1963). (In French)

Enteritis and rectocolitis, caused by mucous radioepithelitis, are now the principal complications following abdominal and pelvic radiotherapy. In a number of cases of radioinduced diarrhea, a new antidiarrheal drug R-1132 (diphenoxylate), which has seemed useful in diarrheas with other etiologies, was tested. R-1132 is an inhibitor of intestinal motricity. It is well tolerated, acts rapidly, and appeared of value in alleviating radiation-induced diarrhea. (J.S.R.)

**6642** THE EFFECT OF INCORPORATED RADIOACTIVE IRON ON THE BIOELECTRIC ACTIVITY OF THE CORTEX OF THE LARGE HEMISPHERES OF RABBITS UNDER PROLONGED EXPERIMENTAL CONDITIONS. D. A. Ginzburg. Materialy po Toksikol. Radioaktivn. Veshchestv, Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR, No. 3, 35-47(1962). (In Russian)

Electroencephalographic examinations were made of rabbits that were treated daily with $Fe^{59}Cl_3$ at a rate of 10 $\mu$C/kg of body weight for a period of 3 months; the control animals were treated with stable Fe salt. The bioelectric potentials were recorded by means of a 4-channel symmetric analyzer, connected to a recording oscillograph, by keeping the animals in a dark room and using a rhythmic photostimulation ranging from 2 to 20 flashes per second. No difference was noted between the treated and the control animals in the response of this stimulation in the occipitoparietal region of the cortex. After 3 to 5 weeks of treatment with $Fe^{59}$ the rhythm signals were broadened at the right side; an added-on rhythm appeared at frequencies up to 15 flashes per second and an electroencephalographic signal was noted in the sensomotor region of the cortex. The added-on signal was unstable. (TTT)

**6643** BLOOD FORMATION IN CASE OF CHRONIC ACTION OF IRON-59. N. L. Beloborodova, V. L. Ponomareva, and E. K. Red'kina. Materialy po Toksikol. Radioaktivn. Veshchestv, Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR, No. 3, 48-55(1962). (In Russian)

The hematopoiesis of rabbits subjected to daily oral treatment with small amounts of $Fe^{59}Cl_3$ at a rate of 1 and 10 $\mu$C/kg of body weight was investigated by means of a morphological study of the bone marrow of the ilium for periods up to 14 months. Myelograms were taken to determine the number or reticulocytes and nuclei. It was found that introduction of 1 to 4 mg/kg of stable $FeCl_3$ caused, during the first months of the experiment, an increase of the hemoglobin content, followed by a corresponding increase of the erythroblasts. Administration of 1 $\mu$C/kg of $Fe^{59}$ resulted in the temporary stimulation of the erythropoiesis. The larger daily amounts of 10 $\mu$C/kg of $Fe^{59}Cl_3$ disturbed the hematopoiesis; simultaneously, the hemoglobin content and the size of the erythrocytes increased. Lymphopenia and qualitative changes of the lymphocytes were observed during the second month after starting the treatment with $Fe^{59}$. (TTT)

**6644** THE PROBLEM OF CHANGES IN THE ERYTHROPOIESIS IN THE CASE OF PROLONGED ACTION OF IRON-59. V. L. Ponomareva. Materialy po Toksikol. Radioaktivn. Veshchestv, Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR, No. 3, 56-66(1962). (In Russian)

Examination of red blood corpuscles is of special interest in the study of the chronic effects of $Fe^{59}$ because the radioactive iron enters into the hemoglobin molecule and thus participates directly in the erythropoiesis. The effect of $Fe^{59}$ on the blood was investigated in rabbits treated with 1 and 10 $\mu$C/kg of $Fe^{59}Cl_3$ or with similar amounts of stable $FeCl_3$. An ocular micrometer was used for measuring the diameters of the erythrocytes during the experiment. It was found that the number of the red corpuscles of the untreated animals varied only slightly; treatment with stable Fe solution resulted in a slight increase in the hemoglobin content; introduction of 10 $\mu$C/kg of $Fe^{59}$ caused a more marked increase and also qualitative changes in the erythrocytes, such as the appearance of macroplanocytosis and enhancement of the anisocytosis at the periphery. The smaller dose resulted in the stimulation of the erythropoiesis during the first months; effects indicating damage to the erythropoietic process appeared later and were less marked than in the case of the large dose. The osmotic resistance remained unchanged in all cases. (TTT)

**6645** BLOOD FORMATION AFTER VENESECTION OF RABBITS SUBJECTED TO CHRONIC TREATMENT WITH IRON-59. N. L. Beloborodova, E. K. Red'kina, and V. L. Ponomareva. Materialy po Toksikol. Radioaktivn. Veshchestv, Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR, No. 3, 67-77(1962). (In Russian)

The regenerative properties of the blood-producing organs of rabbits subjected to daily treatment with $Fe^{59}Cl_3$ for periods of 6 to 7 months were investigated. The animals were subjected to blood letting and were treated with 10 $\mu$C/kg of body of $Fe^{59}Cl_3$ or with the corresponding amount of stable $FeCl_3$. After the $Fe^{59}$ treatment, no difference was noted in the amount of the erythrocytes and the hemoglobin content of the blood of the control and the experimental animals. The treated animals developed more slowly and to a lesser extent the posthemorrhagic reaction in the bone marrow; regeneration of the hemoglobin was also slowed down. The erythroblast portion of the bone marrow was damaged. The absence of posthemorrhagic lymphocytosis and the development of absolute lymphopenia was also observed in the treated animals. The change in the thrombocytopoiesis was indicated by the absence of thrombocytosis after bleeding. Treatment with stable Fe salt after venesection did not have any noticeable effects. (TTT)

**6646** THE EFFECT OF PREGNANCY AND PARTURITION ON THE BLOOD PRODUCTION OF RABBITS SUBJECTED TO THE CHRONIC EFFECTS OF IRON-59. N. L. Beloborodova, V. L. Ponomareva, and E. K. Red'kina. Materialy po Toksikol. Radioaktivn. Veshchestv, Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR, No. 3, 78-85(1962). (In Russian)

During periods of pregnancy and parturition, the hemopoiesis of animals exposed to the chronic effects of $Fe^{59}$ occurs under conditions of iron deficiency and disturbance of the endocrine equilibrium. The problem was investigated by treating female rabbits daily with 10 $\mu$C/kg of body weight of $Fe^{59}Cl_3$ for 10 months prior to pregnancy and mating both the test and the control animals with normal males. The composition of the peripheral blood and the

morphological structure of the bone marrow were systematically examined during the pregnancy and after parturition. The results indicated functional insufficiencies in the blood-forming organs during the test period. Anemia appeared at an earlier stage of the pregnancy and became more marked after parturition, when it was accompanied by pathological changes of the erythrocytes. The absolute number of the lymphocytes decreased during the pregnancy of the treated animals and reached the level of definite lymphopenia. No postparturition lymphocytosis was observed. (TTT)

**6647** CHANGES IN THE PERIPHERAL BLOOD OF WHITE RATS TREATED INTRATRACHEALLY WITH VARIOUS IRON-59 COMPOUNDS. N. D. Sagaidak. Materialy po Toksikol. Radioaktivn. Veshchestv, Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR, No. 3, 86-96(1962). (In Russian)

In view of the selective accumulation of $Fe^{59}$ in the highly radiation-sensitive bone marrow, determination of hematological changes was chosen as a promising method for determining the radiotoxic effect of this isotope. The study involved the examination of the dynamics of changes in the peripheral blood of white rats after the intratracheal administration of insoluble $Fe^{59}$ oxide and soluble $Fe^{59}$ citrate. The amount of hemoglobins erythrocytes, reticulocytes, leukocytes, and the cytological changes were determined every month for a period of 15 months. It was found that introduction of various $Fe^{59}$ compounds in the activity range from 27.5 to 1.06 $\mu$C causes qualitative and quantitative changes in the white blood cells, representing the first stage of damage to hematopoietic activity. The changes consisted primarily in sudden variations of lymphocytes and neutrophilia. Increase of the amount of erythrocytes and of the hemoglobin of the rat's blood is considered a specific effect of $Fe^{59}$. No differences were noted between the effect of the soluble and insoluble compounds. A treatment, repeated 3 times, with 0.03 $\mu$C of $Fe^{59}$ caused less sharp changes than the highly active compounds. (TTT)

**6648** SOME CHANGES IN THE CARBOHYDRATE METABOLISM AND THE ALBUMIN FRACTION OF THE BLOOD SERUM OF RABBITS IN CASE OF CHRONIC TREATMENT WITH IRON-59. R. L. Orlyanskaya. Materialy po Toksikol. Radioaktivn. Veshchestv, Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR, No. 3, 97-105(1962). (In Russian)

A study was undertaken to determine the effect of chronic daily poisoning of rabbits with $Fe^{59}$ on the sugar content of the blood, the albumin fraction, and the total albumin content after treatment with glucose. The results indicated that daily administration of 1 and 10 $\mu$C/kg of body weight of $Fe^{59}$ for a total of 16 months causes only a slight change in the level of the blood sugar; only a chronic exposure to the higher dose resulted in a slight reduction in the sugar level. These animals also exhibited a tendency toward hypoglycemia. No changes were noted in the total albumin content of the serum. Exposure to the higher dose for 6 months caused a reduction of the albumin fraction and a corresponding increase of the globulin content. The A/G ratio was found to decrease first, followed by an increase after a few months. (TTT)

**6649** CHANGES IN THE ELECTROCARDIOGRAMS OF RABBITS SUBJECTED TO PROLONGED INTERNAL TREATMENT WITH IRON-59 TRICHLORIDE. O. A. Saitanov. Materialy po Toksikol. Radioaktivn. Veshchestv, Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR, No. 3, 106-21(1962). (In Russian)

An attempt was made to determine the changes in the cardiac activity of rabbits subjected to prolonged internal exposure to $Fe^{59}Cl_3$, by means of an electrocardiographic study. The animals were treated daily with 1 and 10 $\mu$C/kg of body weight of $Fe^{59}Cl_3$ and with corresponding amounts of stable $FeCl_3$ for periods up to 2 years. The systole was found to possess a sinusoidal character in every case. After the first year, both treated groups exhibited changes in the nervous control of the heart, specifically in the intraauricular and intraventricular conductivity. Disorders were also noted in the irritability, shown by the auricular and ventricular extrasystole and the electric changes in the ventricles. The intraauricular, auriculo-ventricular, and intraventricular conductivity was either at its highest value or was somewhat slowed down; in about one-third of the animals the electric systole of the ventricles was slightly increased. The phase height of the electrocardiographic waves exhibited temporary changes; in a few cases the electric axis of the heart was gradually shifted toward the left. Marked changes were noted in the bioelectric processes after the 7th month of the treatment; the larger dose caused an earlier appearance of the changes. The observed effects were not specific for $Fe^{59}$, as similar behavior was noted in animals treated with $Co^{60}$ or exposed to external ionizing radiation. (TTT)

**6650** THE EFFECT OF THE PROLONGED INTERNAL IRRADIATION OF RABBITS BY SMALL DOSES OF IRON-59 TRICHLORIDE ON THE FUNCTIONAL STATE OF THE HEART. A. O. Saitanov. Materialy po Toksikol. Radioaktivn. Veshchestv, Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR, No. 3, 122-30(1962). (In Russian)

The nerve mechanisms involved in the control of the cardiac activity of rabbits, treated daily with small doses of $Fe^{59}Cl_3$ were examined during periods in which the electrocardiogram did not yet indicate signs of injury. Changes in the neutral control were detected by means of functional tests with $NH_3$ and adrenalin. The animals were treated with 1 and 10 $\mu$C/kg of body weight of $Fe^{59}Cl_3$ or with corresponding amounts of the stable Fe compound for periods of 18 to 20 months. It was found that internal exposure to radioactive Fe causes changes in the response to breathing in of $NH_3$ and to the intravenous injection of adrenalin, in particular in the intensity and the duration of the cardiac reflex of the circulating nerve. During the first 6 to 12 months the reaction is accompanied by a definite bradycardia, followed later by a decrease of the bradycardia. Upon treatment with adrenalin the irritability of many test animals was disturbed, as manifested by the appearance of auricular and nodal electrosystoles and of ventricular paroxysmal tachycardia. There was also a tendency toward changing the repolarization of the myocardium, indicating changes in the cardiac muscle. The effects were more marked in animals treated with the higher doses of $Fe^{59}Cl_3$, but they are considered as being specific for $Fe^{59}$. (TTT)

**6651** MORPHOLOGICAL CHANGES IN THE ORGANS OF ANIMALS EXPOSED TO THE CHRONIC EFFECTS OF IRON-59. E. S. Gaidova. Materialy po Toksikol. Radioaktivn. Veshchestv, Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR, No. 3, 147-59(1962). (In Russian)

The chronic effects of $Fe^{59}Cl_3$, orally administered in daily amounts of 1 and 10 $\mu$C/kg of body weight, on the organs of rabbits was investigated by pathomorphological and microscopic methods, on animals killed $2\frac{1}{2}$ years after the start of the test. The chronic injury is noted by pathological changes that reduce the resistance of the organism and facilitate secondary infections. The majority of the animals exhibited a reduction of the lymphoid tissue in the spleen, accompanied by myeloid blood-forming nuclei. In

addition, pulmonary pneumosclerosis, atypical growth of the epithelium, adenomatosis of the mucous glands of the bronchia, edema of the myocardium, atrophy, and sclerosis of the mucous layer of the gastrointestinal tract were noted, together with distrophic and occasionally necrobiotic changes of the liver and kidneys, atropy of the sexual glands, and generalized adiposity. These pathological changes were a direct effect of the administered $Fe^{59}$. (TTT)

**6652** THE POSSIBILITY OF DETERMINING RESPONSE OF AN ORGANISM TO LIGHT IONIZING RADIATIONS BY MEANS OF ASCERTAINING PHOSPHENE THRESHOLD OF THE RETINA. V. Glavaty, Z. Dienstbier, and M. Zhak (Charles Univ., Prague). Med. Radiol., 8: No. 11, 47-50(Nov. 1963). (In Russian)

Studies were made on a suitable diagnostic method for ascertaining smaller doses of irradiation. The matter concerns in the main changes in receptivity threshold (phosphene threshold) ascertained by electric irritation of the eye. The values are supposed to increase reliably along with the increase of the irradiation dose. In employing this method, it was found that the increase of the two values took place only in 28.57 per cent of all cases under investigation. The accuracy of the method cannot be possibly improved since phosphene receptivity process is purely subjective and depends on the mental and physical state of a person under investigation. The difference between the phosphene threshold and the phosphene index prior to and after exposure is not adequate to the dose, and it follows hence that it cannot be relied upon in the diagnosis of the irradiation value. (auth)

**6653** TRANSMISSION OF X-RAY INDUCED LA VÚFB LEUKEMIA BY A CELL-FREE FILTRATE. J. Libánský, M. Láznička, J. Libánská, and J. Jirásek (Inst. of Hematology and Blood Transfusion and Inst. of Pathological Anatomy, Prague). Neoplasma, 10: 487-505(1963).

Successful transmission of LA VÚFB leukemia by a cell-free filtrate is reported. This leukemia was originally induced in C57 black mice by x rays. At the time when the cell-free filtrate was being prepared from leukemic spleen and node, this irradiation-leukemia was already in its 170th passage. The passages were always performed by means of leukemic cells only. Leukemia induced by application of cell-free filtrate from the original irradiation-leukemia was transmitted in the same way to the third passage and not only to newborn, but also to adult mice of the same strain. The incidence of leukemias was 50%, and the period of latency 6 months. The type of leukemia was the same in all of the passages. It was lymphatic leukemia, differing from the initial, x-ray-induced leukemia by the considerable enlargement of nodes and thymus; otherwise the characteristics of both were identical. The clinical course, macroscopic morphology, histology, and cytology of this leukemia are described. In addition alterations in the fine structure of kidney tubuli-mitochondrias were found, the specificity of which for the basic disease will have to be checked for a longer period of time. (auth)

**6654** THE HISTOCHEMICAL BEHAVIOR OF SUCCINODEHYDROGENASE IN THE HUMAN INTESTINE AFTER IRRADIATION. R. De Dominicis, G. Nori Bufalini, P. Gentilini, and V. Mallegni (Università, Florence). Radiobiol. Latina, 5: 309-27(Oct.-Dec. 1962). (In Italian)

Modifications of the succinodehydrogenasic activity in the large and small intestine of humans treated by irradiation were examined. Following ionizing treatment ($Co^{60}$) it was found that doses above 600 rad for the large and above 1,000 rad for the small intestine do not lead to any morphological alterations of the mucosa but do lead to an increase in the numbers of dinitrophormozane granula in the lining epithelium and to their dispersion in the whole of the cytoplasm. These modifications were interpreted as a consequence of the increased permeability of the mytochondrial membranes, allowing the enzyme to diffuse in the surrounding cytoplasm. Radiation doses above 1,500 rad lead to to more marked alterations and to a decrease of the enzymatic activity; however, these doses cause morphological alterations of the mucosa too. Particularly severe lesions were found in the cells of the bottom of glandular tubuli, probably due to their greater radiosensitivity, both in the case of Paneth cells, of enterocytes, and of cells of the lining epithelium. At the same time necrotic processes become evident. By increasing the doses of irradiation, two parallel facts become evident: a still more marked cellular suffering and a decrease of the enzymatic activity leading to its complete disappearance. It was concluded that the succinodehydrogenasic activity may show even with its initial alterations a functional alteration to the cell, which cannot be shown from the morphological point of view even when using the electronic microscope. At the same time, however, since an evident decrease shows up only when there is a marked suffering of the mucosa, it is emphasized that the enzyme shows a relative resistance to radiations. (auth)

**6655** EFFECTS OF ROENTGEN IRRADIATION ON HYDRIC METABOLISM, ON THE URINARY ELIMINATION OF CREATINE AND CREATININE, AND ON THE GLYCOGEN CONTENT OF THE LIVER AND MUSCLES IN TWO DIFFERENT STRAINS OF RATS. M. Bindoni, U. Meldolesi, C. Rapisarda, and R. Rizzo (Università, Catania, Italy). Radiobiol. Latina, 5: 329-45(Oct.-Dec. 1962). (In Italian)

In the grey wild rat fed only with aqua fontis, irradiation (700r) led during the 24 hours following irradiation, to polyuria, polidypsia, and increases in the urinary excretion of creatine and creatinine. These effects were not present in the albino rat. In the wild gret rat fed with a 0.25 M solution of saccharaose right after irradiation (700r) the urinary excretion as compared to the one of the same strain of animals given aqua fontis was considerably reduced. Following irradiation at 700r of the animal kept with aqua fontis, the glycogen content of the liver was considerably increased in albino rats and slightly increased in wild grey rats, as compared to stressed controls. Muscle glycogen following irradiation, did not show significant variations in either strain of rats. (auth)

**6656** ON THE FUNCTIONALITY OF THE R.H.S. UNDER THE INFLUENCE OF PAN-IRRADIATION. STUDIES CONDUCTED WITH THE HELP OF COLLOIDAL $Au^{198}$. S. Romeo, A. Billitteri, and G. Gasso (Università, Catania, Italy). Radiobiol. Latina, 5: 477-81(Oct.-Dec. 1962). (In Italian)

In rabbits having undergone pan-irradiation with one single mortal dose of 1,000r, the function of the reticulohistiocytary system was investigated by an evaluation of the granulopexic index, which was studied by the intravenous injection of a colloidal suspension of $Au^{198}$. This investigation was performed some 11 hours and 5 days following irradiation. It was established that the granulopexic index is considerably reduced in treated animals as compared to controls; conversely, the slight difference between the two groups of irradiated animals does not appear to be significant. (auth)

**6657** VARIATION OF IMMUTABILITY OF IRRADIATED ANIMALS IN HIBERNATION. G. Gasso, A. Billitteri,

and S. Romeo (Università, Catania, Italy). Radiobiol. Latina, 5: 501-5(Oct.-Dec. 1962). (In Italian)

The function of the histiocytary system was evaluated in animals having undergone a mortal dose of ionizing radiations (1,000r) given in one single treatment both at physiological body temperature and in controlled hypothermy. It was found that in animals irradiated under hypothermy there is no sign of the decrease in the granulopexic index that is found in animals undergoing the same radiation treatment at physiological body temperature. This result should be ascribed to the considerable increase of the granulopexic index caused by hypothermy. (auth)

**6658** PHARMACOLOGICAL MODIFICATIONS OF THE RESPONSE OF ORGANISMS TO RADIOLESIONS. INHIBITION OF THE CNS AND ENDOCRINE STIMULATION. B. Rosee and G. Poggi Longostrevi (Ospedale Maggiore, Milan). Radiobiol. Radioterap. Fis. Med., 18: 72-7(Jan.-Feb. 1963). (In Italian)

By taking the experiences of Bacq, Betz, Fischer, and Smith as a starting point, the possible relationships existing between CNS (Central nervous system) and hypophysis-adrenal axis in case of lesions due to panirradiation are explained. Research that associates the inhibition of CNS (obtained by means of barbiturates, luminal) to the direct stimulation of the adrenal glands by means of retarded action ACTH was conducted. During the first ten days following irradiation, a decrease in bodyweight was observed, more evident in the pharmacologically-treated rats. In this group afterwards there was seen some recovery, whereas in the rats that were only irradiated a fast and continuous decay was started. Percentages of survival after the first week following irradiation were quite favorable to the pharmacologically treated rats. It was therefore concluded that a large organic resistance to damage due to radiolesions can be obtained by influencing the hypophysis-adrenal axis and by inhibiting, at the same time, the influence of CNS. (auth)

**6659** EFFECTS OF PAN IRRADIATION ON THE ERYTHROCYTIC ENZYMATIC ACTIVITY OF GLUCOSE-6-PHOSPHATE DEHYDROGENASE. Gaspare Sanna (Ospedale Civile, Cesena, Italy). Radiobiol. Radioterap. Fis. Med., 18: 78-86(Jan.-Feb. 1963). (In Italian)

The effect of total-body x irradiation on rabbit cell glucose-6-phosphate dehydrogenase was investigated. Irradiation caused a decrease of the enzyme level, which occurred in a few hours, increased progressively, and was not related to the contemporary variations of hematocrit. It is suggested that the damage of erythrocytes caused by irradiation may be due to the decrease of G-6PD. (auth)

**6660** A STUDY OF DEOXYRIBONUCLEIC ACID, BY THE METHOD OF ELECTRON MICROSCOPY. A. M. Tongur, A. L. Zaides, and A. G. Pasynskii (Bakh Inst. of Biochemistry, Moscow). Radiobiologiya, 3: 492-3(1963). (In Russian)

Results are reported from viscometric measurements and electron microscopic observations on the effects of 2.5-, 5-, and 10-kv doses of x radiation on DNA preparations from calf thyroid glands. Observations on irradiated samples maintained at 27° for several hours showed a reduced viscosity immediately after irradiation with no subsequent changes. After 1 hr the DNA molecules appeared to break into shorter sections, and 2 hr after irradiation a considerable number of threadlike and globular particles appeared that indicated marked structural changes. The structural changes were manifest earlier with larger radiation doses. It was concluded that the structural changes observed in irradiated DNA are of great significance in the radioinduced disturbances of biological functions of nucleic acids. (C.H.)

**6661** X-IRRADIATION-INDUCED CHANGES IN OXYHEMOGLOBIN SPECTRAL CHARACTERISTICS. I. V. Vysochina (Inst. of Biology and Physics, Moscow). Radiobiologiya, 3: 494-500(1963). (In Russian)

Possible reaction mechanisms involved in the immediate damage to respiration function of the blood after radiation exposure are discussed. Results are reported from an investigation of changes in the electron absorption spectrum of oxyhemoglobin solutions obtained from the blood of lethally x irradiated rabbits and rats as well as of the spectra of oxyhemoglobin solutions obtained from blood irradiated in vitro. Changes in the oxyhemoglobin spectrum were observed in all samples immediately after irradiation. These changes were irreversible and increased only slightly with time. Similar changes were observed in a sample of human blood irradiated in vitro. An analysis of the data led to the conclusion that radiation acts upon the hemoglobin molecule at the site of addition of oxygen to the molecule. Reaction mechanisms involved are discussed. It was concluded that the observed changes in the oxyhemoglobin spectrum after irradiation were due to the excitation of additional electron levels either of the Fe of heme or of the N of the imidazole histidine residue of the protein fraction of the molecule. As a result, an additional coordination bond of heme Fe with globin cannot be formed upon oxygenation and the addition of O becomes hampered. (C.H.)

**6662** DEOXYRIBONUCLEASE ACTIVITY IN RABBIT LIVER AFFECTED BY PLUTONIUM. V. V. Konstantinova. Radiobiologiya, 3: 501-3(1963). (In Russian)

Plutonium administered as a nitrate to rabbits in a single dose of 7 $\mu$C/kg body weight caused liver cirrhosis in 77.5% of the animals within 3 to 6 months and death of most of the animals 6 to 8 months after intravenous injection of the Pu. Measurements of DNAase activity of liver at various times after the injection of Pu showed an initial decrease in DNAase activity by the 3rd day followed by a gradual increase up to 4.5 months when the activity of DNAase reached maximum value and showed a 3.8-fold increase. A second decrease was noted at 6 months, but the DNAase activity remained 74.5% higher than that of the controls. It was concluded that the increase of DNAase activity in the liver was due to a disturbance of mitochondrial structure induced by $\alpha$ particles and also to DNA decomposition. (C.H.)

**6663** EFFECTS OF WHOLE-BODY X-IRRADIATION ON THE CONTENT OF GAMMA-AMINOBUTYRIC ACID IN CEREBRAL TISSUE. A. P. Sotnikova and I. A. Sytinskiĭ (Leningrad State Univ.). Radiobiologiya, 3: 504-7 (1963). (In Russian)

Whole-body exposure to 1,000 r x radiation had no effect on the content of $\gamma$-aminobutyric acid (GABA) or of glutamic acid in the brain of rats. An immediate decrease and subsequent recovery in the functional state of the brain were demonstrated in the irradiated animals by measurements of electric activity. The administration of sodium amytal, cysteamine, and $\beta$-aminoethylisothiuronium had no effect on the content of GABA and glutamic acid in the brain of irradiated and control rats. (C.H.)

**6664** PECULIARITIES IN THE SYNTHESIS OF SERUM ALBUMIN IN CHICKS DURING ACUTE RADIATION SICKNESS. O. G. Zamyatkina (Inst. of Biological and Medical Chemistry, Moscow). Radiobiologiya, 3: 508-13(1963). (In Russian)

A decrease in the synthesis of serum albumin in the liver of chicks was noted 5 to 6 hr after exposure to various doses of x radiation only in liver sliced from chicks in a state of shock at the time of death. In chicks that had survived shock resulting from doses of 1,000 r and in chicks exposed to 500 r a decrease in serum albumin synthesis was observed only during the acute stage of radiation sickness that occurred on the 3rd to the 12th day. Disturbances in the synthesis of serum albumin in the liver were followed by a decrease in concentration in the blood of irradiated chicks. Lowered food consumption during radiation sickness did not cause the decrease in the synthesis of serum albumin in the liver. (C.H.)

**6665** CHANGES IN NUCLEOSIDE CONTENT OF RAT URINE DURING RADIATION INJURY. P. D. Gorizontov, T. A. Fedorova, Yu. A. Zharkov, O. Ya. Tereshchenko, S. S. Khnychev, and M. F. Sbitneva. Radiobiologiya, 3: 514-17(1963). (In Russian)

Changes in the nucleoside content of urine induced by whole-body exposure of rats to 600 r doses of x and $\gamma$ radiation were studied in an attempt to find an indication of the degree of radiation injury. Total nucleoside excretion was measured by a modification of Dasche's method. The content of desoxycytidine and thymidine in urine was determined by paper chromatography after separation on an ion exchange column. During the first 24 hr following irradiation there was a marked increase in urinary excretion of total nucleosides, desoxycytidine, and thymidine, followed by a decrease by the 3rd post-irradiation day. A rise on the 6th through the 10th day was attributed to a rise in thymidine excretion at this stage. The injection of suspensions of bone marrow cells with subsequent daily injections of biomycin had no effect on the nucleoside content of urine in irradiated rats. (C.H.)

**6666** COMBINED ACTION OF SMALL DOSES OF EXTERNAL GAMMA IRRADIATION AND STRONTIUM-90 UPON HEMOPOIESIS IN DOGS. M. F. Aleksandrova and V. S. Kushneva. Radiobiologiya, 3: 523-8(1963). (In Russian)

Observations over a 3-yr period are reported on the blood picture in dogs exposed to chronic low-level $\gamma$ radiation, chronic low doses of $Sr^{90}$, and the combined effects of chronic external $\gamma$ exposure and internal $Sr^{90}$. All radiation doses were less than two orders higher than the maximum permissible levels. The total absorbed dose in the skeleton averaged 2355 rads. Analyses of peripheral blood were performed every month and sternal punctures were performed every 2 months. Data are presented on changes in hematopoiesis and in behavior of the dogs observed at various times during the period of exposure. (C.H.)

**6667** SIGNIFICANCE OF TISSUE GLOBULINS IN THE DEVELOPMENT OF TOXEMIA AFTER IRRADIATION. Yu. D. Balika and G. M. L'vitsyna. Radiobiologiya, 3: 529-34(1963). (In Russian)

The role of tissue globulins in the pathogenesis of radiation sickness was investigated in dogs. It is pointed out that globulins consist mainly of antibodies and products of cell decomposition and play a leading role in immune reactions. Results are reported from studies of the biological actions of $\gamma$ globulin fractions isolated from tissue perfusate of irradiated animals. Globulin depressed erythropoiesis and decreased immune reactions when injected into healthy dogs. An increase in leukocytic activity of globulin was demonstrated in in vitro experiments. It was concluded that globulin is one of the toxic factors involved in the pathogenesis of radiation sickness. (C.H.)

**6668** ISOHEMOTRANSFUSION-INDUCED LEUKOCYTIC REACTIONS IN IRRADIATED RATS. R. F. Yurin (Moscow State Univ.). Radiobiologiya, 3: 535-9(1963). (In Russian)

Rats exposed to 450 r x radiation were given transfusions of whole isologous blood 6 hr, 3 days, 4 weeks, or 8 weeks later. Leukocyte reactions were studied by cell and differential counts before irradiation, before transfusion, and 1, 2, 3, and 6 hr after transfusion. An initial neutropenia was observed in transfused irradiated rats and also in rats transfused with physiological saline. It was concluded that the leukocytic reaction to transfusion cannot be considered as a specific one for isohemotransfusion. It is postulated that the white blood system in rats has a high nonspecific sensitivity to stimuli that affects the vascular system. (C.H.)

**6669** A STUDY OF CERTAIN MANIFESTATIONS OF AUTOMATISM IN FROG INTESTINE AFTER WHOLE-BODY GAMMA IRRADIATION. M. N. Murav'ev. Radiobiologiya, 3: 540-4(1963). (In Russian)

Whole-body exposure of frogs to 50-kr $\gamma$ radiation induced changes in the rhythmic activity of isolated segments of the intestine and changes in the sensitivity of intestine to acetylcholine and adrenaline. Possible reaction mechanisms involved are discussed. (C.H.)

**6670** A NEW POSSIBLE USE OF IONIZING RADIATION IN MEAT INDUSTRY. A. M. Kuzin and M. P. Silaev (Moscow Technological Inst. of Meat and Milk Industry). Radiobiologiya, 3: 545-8(1963). (In Russian)

Exposure of chickens to 850 rads of $Co^{60}$ $\gamma$ radiation 24 hr before slaughtering retarded undesirable fermentative changes in poultry meat stored at room temperature in closed containers. Results of an organoleptic analysis made after 9 months of storage showed that the poultry meat preserved original properties and had no signs of fermentative spoilage. Data are included from studies of the biochemical and physicochemical properties of poultry meat. (C.H.)

**6671** INFLUENCE OF PROLONGED EXTERNAL IRRADIATION ON CLOSING FUNCTION OF THE CEREBRAL CORTEX. Z. A. Yanson. Radiobiologiya, 3: 549-56(1963). (In Russian)

The effects of chronic exposure to doses of 0.36 r/min $\gamma$ radiation on response of the central nervous system to external stimuli were studied in rabbits. Rhythmic light was used as a conditioned stimulus, electrocutaneous stimulation was used as an unconditioned stimulus, and sound was used as an acoustic stimulus in various combinations with the conditioned and unconditioned stimuli. Electroencephalograms taken daily were examined for changes in nervous response during the 10- to 12-day period before death of the animals. Impaired response to visual and acoustic stimuli observed during the first 3 days was accompanied by an increase in respiratory rate that somewhat compensated for the decreased nervous response. After the 4th day the radiation disturbed both the electric activity and respiratory rhythm in the brain and the development of temporary synapse was rendered difficult. By the 10th day only short periods of synchronization of electric potentials existed, respiration was depressed, and conditioned reflexes were destroyed. (C.H.)

**6672** CYTOGENETIC RADIOSENSITIVITY OF CERTAIN STAGES OF MEIOSIS IN MONKEYS AND MICE. M. A. Arsen'eva and N. P. Bochkov (Inst. of Biology and

Physics, Moscow and Inst. of Experimental Pathology and Therapy, Academy of Medical Sciences, USSR). Radiobiologiya, 3: 563-9(1963). (In Russian)

A comparison of the radiosensitivity of the testis of mice and monkeys (Macaca mulatta) exposed to 50 or 100 r x radiation showed that monkeys are 2 to 2.5 times more sensitive to gonadal irradiation than mice. Chromosome aberrations during mitosis in spermatocytes and germinal epithelium were used as an index of radiation damage. (C.H.)

**6673** COMPARATIVE ANALYSIS OF THE RADIOSENSITIVITY OF SPERMATOGONIA OF VARIOUS TYPES IN MACACA MULATTA. E. D. Bakulina and N. N. Orlova (Inst. of Biology and Physics, Moscow). Radiobiologiya, 3: 570-5(1963). (In Russian)

Results are reported from a study of the radiosensitivity of spermatogonia during various developmental stages in monkeys (Macaca mulatta). An attempt was made to establish the cause of temporary sterility in monkeys expcsed to doses of 50 or 100 r x radiation. Comparison of results with data on mice showed that spermatogonia of all types are more radiosensitive in monkeys than in mice. (C.H.)

**6674** EFFECTS OF CHRONIC GAMMA IRRADIATION ON SHOOTS' GROWTH, FLOWER BUD FORMATION AND YIELDING CAPACITY OF CHERRY-MAZZARD HYBRIDS. G. N. Imamaliev (Inst. of Biology and Physics, Moscow). Radiobiologiya, 3: 615-20(1963). (In Russian)

The effects of exposure to several dose levels of chronic $\gamma$ radiation on growth, development, formation of flower buds, and fruit yield were studied in hybrids of the sweet cherry. Exposure to a total dose of 153 r during the vegetation period administered at an intensity of 0.150 r/hr stimulated shoot growth, the formation of flower buds, and the setting of fruit. (C.H.)

**6675** STERILIZATION OF BONY TISSUE BY $Co^{60}$ GAMMA RAYS. E. N. Sautin (Central Inst. of Traumatology and Orthopedics, Ministry of Public Health, Moscow). Radiobiologiya, 3: 621-5(1963). (In Russian)

Exposure of samples of lyophilized bone to 4,000,000 rep $Co^{60}$ $\gamma$ radiation resulted in complete sterility of the bone and had no effect on the morphological structures of the bone. The method is recommended for the treatment of bone tissues for use in transplantation during restorative surgery. (C.H.)

**6676** STUDY ON THE ABSORPTION OF OLEIC ACID $I^{131}$ IN PATIENTS IRRADIATED WITH $Co^{60}$ AT THE ABDOMINAL-PELVIC REGION. Ludovico Dalla Palma, Anna Miliani, and Silano Citi (Università, Florence). Radiol. Med., 49: 896-906(Oct. 1963). (In Italian)

In a continuation of studies on the intestinal absorption of fats in subjects irradiated with $Co^{60}$ in the abdominal-pelvic region, the absorption behavior of oleic acid labeled with $I^{131}$ was studied. Unlike the case of triolein, a fair percentage of subjects who did not reveal any changes in the absorption values during or after irradiation were found. The other subjects displayed involvement of the absorption that differed according to the starting values and, in general, was less marked than those observed with triolein. No parallelism was observed between the size of the dose and the degree of involvement of the intestinal absorption. (auth)

**6677** ERYTHROPOIETIN PRODUCTION FOLLOWING GAMMA IRRADIATION AND HEMORRHAGE IN DOGS. N. Pesic, M. Radotic, and S. Hajdukovic (Inst. of Nuclear Sciences "Boris Kidrich," Belgrade). Science, 143: 49-50 (Jan. 3, 1964).

The possible role of erythropoietin as a stimulating factor for the recovery of erythropoiesis was investigated in irradiated dogs. Results showed that the production of erythropoietin increased after exposure to 300 rad of $\gamma$ radiation and subjection to artificial hemorrhage. (C.H.)

**6678** TRIPLOIDY INDUCED BY GAMMA IRRADIATION DURING MEIOSIS IN SUNFLOWER. B. I. Pozsar, E. Kurnik, and J. Parragh (Agricultural Experimental Inst., Iregszemcse, Hungary). Zeuchter, 33: 65-8(1963).

The selected Iregi csikos (Striped Ireg) sunflower variety was irradiated prior to the onset of flowering in the early phase of microsporogenesis with a 20-kr dose of $\gamma$ rays from a $Co^{60}$ source. Profound alterations in cytologic, morphologic, and physiologic behavior resulted from this dose. In untreated flowers, microsporogenesis is regular, and four haploid cells (tetrad) are produced during the mitosis following meiosis. The chromosome sets disintegrate under the effect of the 20-kr dose, and not all of them move away one from the other. The four haploid chromosome components are formed regularly, but the two mitoses taking place in the cell are no longer synchronous. Compared with the regularly disintegrating two chromosome sets, the other two chromosome sets remain near one another, even at the end of the disaster stage. During the spirem stages a tetrad is not produced but a triad, due to synchronous divergence. In the triad the first and second chromosome sets are haploid and enable the production of normal pollens, while the third member of the triad is diploid and leads therefore to the formation of pollen of abnormal shape and function. Some develop fruits of triploid (3n = 51) progenes. Samples taken from the root tips of seedlings developing from selfed fruits showed a large number with triploid chromosome number. Thus, irradiation of plants which originally had a diploid chromosome number of 34 led to the production of a considerable number (3.80%) of triploid progeny. The chromosomes were either thinned and stained poorly or shortened and more intensely stained than controls. Decreased nucleic acid or nucleoprotein content in the poorly stainable chromosomes of relatively thin structure observed in the mitotic division of triploids was regarded as evidence of x-ray injury. (BBB)

**6679** PROCESS FOR TREATING CULTIVATED VEGETABLES BY MEANS OF IONIZING RADIATIONS. Pierre Vidal. British Patent 945,490. Jan. 2, 1964. Priority date Apr. 9, 1959, France.

A process is given for irradiating plants to accelerate growth and to increase yield. The process comprises irradiating a seed or some other such unit from a plant during its vegetative activity (germination) and before it is inserted into a nitritious medium. Examples of the process are given using corn seeds, potato tubers, and onions. (D.L.C.)

## Radiation Effects Therapy and Countermeasures

**6680** PROTECTION OF SULFHYDRYL COMPOUNDS AGAINST IONIZING RADIATION. Alexander Pihl and Tore Sanner (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Biochim. Biophys. Acta, 78: 537-9 (Nov. 15, 1963).

Cysteamine was shown to provide strong protection against x-ray inactivation of papain and of a small molecular compound, CoA, in solutions. The mechanism involved modification of their -SH groups. It is concluded

that results are compatible with the hypothesis that the protection afforded by sulfhydryl compounds in vivo may be due in part to blocking of biologically important sulfhydryl groups. (C.H.)

**6681** THE RECOVERY OF LETHALLY IRRADIATED DOGS GIVEN INFUSIONS OF AUTOLOGOUS LEUKOCYTES PRESERVED AT −80°C. John A. Cavins, Stuart C. Scheer, E. Donnall Thomas, and Joseph W. Ferrebee (Mary Imogene Bassett Hospital, Cooperstown, N. Y.). Blood, 23: 38-43(Jan. 1964).

Nine normal mongrel dogs were exposed to 1200 r whole-body irradiation at 4 to 5 r/min. They were then given intravenous infusions of 2.12 to 20 × $10^9$ autologous leukocytes that had been previously stored at −80°C in 10% dimethylsulfoxide. Three dogs survived with delayed but complete hematopoietic recovery. Three showed beginning marrow regeneration but died within 3 to 4 weeks of irradiation. Three given less than 6 × $10^9$ cells died within 21 days. The number of leukocytes infused was critical since there was no survivor among the dogs receiving less than 9 × $10^9$ cells. It is concluded that peripheral blood contains primitive cells capable of repopulating marrow spaces and restoring marrow function. (auth)

**6682** AUTOLOGOUS BONE MARROW TRANSPLANTATION STUDIES IN DOGS IRRADIATED BY $Y^{90}$-DTPA URINE-RECYCLING TECHNIC. H. S. Winchell, Myron Pollycove, W. D. Loughman, and J. H. Lawrence (Univ. of California, Berkeley). Blood, 23: 44-52(Jan. 1964).

Autologous bone marrow infusions were able to save the lives of dogs lethally irradiated with $Y^{90}$-DTPA. In certain cases the autologous marrow was able to save the life of the $Y^{90}$-DTPA-irradiated dogs without any marked early elevation in circulating formed blood elemnets. In contrast to results obtained using external irradiation technics, animals treated with $Y^{90}$-DTPA and autologous marrow did not show early return of circulating lymphocytes. (auth)

**6683** DOSE DISTRIBUTION IN MOVING BEAM COBALT 60 TELETHERAPY. A GENERALISED CALCULATION METHOD. J. van de Geijn (H. Joannes de Deo Hospital, Hague). Brit. J. Radiol., 36: 879-85(Dec. 1963).

The theory and practical application are presented of a new method for the calculation of dose distributions obtained with moving beams of $Co^{60}$ radiation. The method is based on a generalization of the tumor-air-ratio principle and was proved to be adequate by means of experimental investigations in a specially designed water phantom. (auth)

**6684** REVERSAL OF THE THYMUS-DEPENDENT INFLUENCE IN RADIATION LEUKEMOGENESIS OF C57BL MICE. L. W. Law, T. R. Bradley, and Sam Rose (National Cancer Inst., Bethesda, Md.). J. Natl. Cancer Inst., 31: 1461-77(Dec. 1963).

A striking inhibition of lymphocytic neoplasms was observed in C57BL strain thymectomized and irradiated mice bearing isogenic grafts of thymic tissue under the renal capsule. A frequency of less than 5% was observed in each of 3 groups. In contrast, thymectomized and irradiated C57BL mice bearing isogenic thymic grafts in the subcutaneous connective tissues developed a frequency of disease, with a mean age at death approaching the pattern found in intact, fractionally irradiated mice. Grafted thymic tissue was invariably found to be lymphosarcomatous. Microscopic examination at serial intervals of thymic tissue grafted at each site showed no pronounced differences. Well-developed grafts with morphologically preserved thymic architecture persisted under the renal capsule for as long as 14 months. Possible mechanisms for this inhibition are suggested and discussed. (auth)

**6685** THE EFFECT OF THE CALCIUM-DISODIUM SALT OF DIAMINO CYCLOHEXANE TETRAACETIC ACID ($CaNa_2$DCTA), THE CALCIUM-DISODIUM SALT OF ETHYLENE DIAMINO TETRAACETIC ACID ($CaNa_2$EDTA) AND OF PECTIN ON THE DISTRIBUTION AND ELIMINATION OF IRON-59 FROM THE ORGANISM. A. A. Rubanovskaya. Materialy po Toksikol. Radioaktivn. Veshchestv, Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR, No. 3, 160-8(1962). (In Russian)

Among other steps, the therapy of radiation sickness involves the use of agents that accelerate the removal of radioactive materials from the organism; the action of these agents is due to their ability to form stable, water-soluble complexes that are rapidly eliminated through the kidneys. The effect of these complexing agents was investigated on rats treated with 10 μC/kg of body weight of $Fe^{59}$ citrate. The complexon was administered after 1 to 2 minutes, 1 hour, 3½ hours, 2 days, and 11 days intra-abdominally, intravenously, or orally. The animals were killed 1 day after the treatment and the activity of the excretions, the tissues, and the organs determined. The results showed that the intra-abdominal or intravenous injection of the agent a short time after the administration of the isotope causes a 2- to 3-fold increase of the elimination of $Fe^{59}$ through urinary secretion and reduction of the amount precipitated in the tissues. The amount of $Fe^{59}$ eliminated is dependent on the relative amount of the stable carrier present. Injection of the complexon after 11 days is only slightly effective. The $CaNa_2$ salts of both DCTA and EDTA were equally effective in this respect. Pectin was found to reduce the absorption of $Fe^{59}$ in the gastrointestinal tract if the isotope was introduced orally with a small amount of carrier. (TTT)

**6686** TREATMENT OF RADIATION INJURIES OF THE SKIN AND MUCOUS MEMBRANES WITH CHLOROPHYLL-CAROTENE PASTE. L. M. Stukova, S. V. Strutskovaya, V. A. Repina, and V. P. Lukyanov (Research Inst. of Medical Radiobiology, Ministry of Health, USSR). Med. Radiol., 8: No. 11, 30-3(Nov. 1963). (In Russian)

A clinical trial on chlorophyll-carotene paste for the treatment of radiation injuries of the skin and mucous membranes is discussed. The preparation exerted a favorable influence over the course of the inflammatory process and acceleration of reparative reactions. The technique involving the use of the above preparation is described. (auth)

**6687** CLINICAL MANIFESTATIONS OF THE HUMAN BODY IN A SINGLE EXPOSURE TO $Cs^{137}$. V. I. Kiryushkin, V. N. Dotshenko, V. N. Podgoretskaya, and Z. B. Tokarskaya. Med. Radiol., 8: No. 11, 33-40(Nov. 1963). (In Russian)

The results of clinico-laboratory observations on 5 persons who had sustained a single exposure to $Cs^{137}$ (60-106) are reported. No typical symptoms of radiation sickness were observed. During the first weeks of observation mild disturbances of the neuroendocrine regulation were noted primarily associated with psychoemotional shifts. At the same time during this period and later functional disorders of the liver and changes in the peripheral blood were seen, this, apparently, being the result of the action of relatively small quantities of $Cs^{137}$. (auth)

**6688** FEATURES SPECIFIC TO THE COURSE OF ACUTE CORONARY INSUFFICIENCY IN RADIATION SICKNESS CAUSED BY POLONIUM ($Po^{210}$) X-RAY RADIATION, AS WELL AS UNDER CONDITIONS OF

LOCAL IRRADIATION OF HEART REGION. V. M. Volodin. Med. Radiol., 8: No. 11, 50-5(Nov. 1963). (In Russian)

Studies were made on features specific to the course of acute coronary insufficiency induced by pituitrin in rabbits exposed to total x irradiation (800 r), local irradiation of the heart region, and by the subcutaneous introduction of $Po^{210}$ (0.1 and 0.05 mC/kg). On the first day after roentgen irradiation and at the sickness peak (8th-15th day) and also on the 9th-15th day after $Po^{210}$ affection acute exacerbation of coronary insufficiency was revealed following the introduction of pituitrin, which in a number of cases, brought about death of the animals. In the terminal period of the sickness response to pituitrin was less marked. Local irradiation led to increased disorders of cardiac function on the 3rd-7th day after irradiation. Peculiar features of the course of coronary insufficiency caused by pituitrin may be brought about by metabolic disorders of the myocardium as well as by alterations in hemodynamics when the organism is exposed to irradiation. (auth)

**6689** THE EFFECT OF PRELIMINARY IMMUNIZATION WITH LIVE VACCINES ON THE COURSE AND OUTCOME OF RADIATION SICKNESS IN RABBITS. A. M. Sudnov (Third City Hospital, Zagorsk, USSR). Med. Radiol., 8: No. 11, 55-9(Nov. 1963). (In Russian)

Experimental investigations on rabbits conducted for the purpose of elucidating the effect of live vaccines on the organism of the irradiated animal established that the number of animals perishing during sublethal x irradiation decreases if a live vaccine is introduced subcutaneously. The number of perished animals augmented if they were immunized with the live vaccine during or after irradiation. It was concluded that it is possible to use the live vaccine for the prevention of radiation sickness in patients subjected to x irradiation for therapeutic purposes. (P.C.H.)

**6690** DISTRIBUTION OF $P^{32}$ IN THE TISSUES OF RAT ORGANS UNDER THE ACTION OF PENETRATING RADIATIONS AND AFTER THE INTRODUCTION OF ACTH. P. I. Lomonos and A. Shamakhmudov (Inst. of Experimental Medicine, Academy of Medical Sciences, USSR). Med. Radiol., 8: No. 11, 59-63(Nov. 1963). (In Russian)

Distribution of indicating doses of $P^{32}$ (20 C/kg) in the tissues of albino rat organs was studied with a view of determining the state of histohematic barries. The objects of investigation were the blood, liver, kidney, spleen, heart, suprarenals, and the brain. Following total exposure to x rays in a dose of 800 r, and after the introduction of ACTH (in proportion of 2 units per 100 g of body weight) no activation whatsoever was rendered on the 1st, 3rd, and 6th day after the exposure. The highest permeability in control animals was revealed in the liver tissue, somewhat lower in the tissue of kidneys, suprarenals, and spleen, and the lowest in the brain. On the 3rd and 4th day of the radiation sickness permeability of the tissues of all the organs under investigation became markedly higher, while on the 1st and 6th day no essential changes were observed. After the introduction of ACTH to unexposed animals a marked increase of permeability was observed in the tissue of suprarenals, and marked changes in blood formules occurred. After the introduction of ACTH on the 3rd day after the exposure the tissue penetrance was lowered, except for suprarenals, where it did not undergo any discernible change. A higher permeability in the tissues of suprarenals was again marked on the 6th day of the radiation sickness course, but at later periods after hormone introduction. (auth)

**6691** ON THE PROBABLE ROLE OF DNA DENATURATION IN BIOLOGICAL ACTION OF RADIANT ENERGY AND IN MUTAGENESIS. R. I. Salganik (Inst. of Cytology and Genetics, Siberian Branch, Academy of Sciences, Novosibirsk, USSR). Radiobiologiya, 3: 489-91 (1963). (In Russian)

An attempt is made to explain the biological effects of radiation on the basis of radioinduced denaturation of DNA. Data are summarized from studies on DNA denaturation associated with the action of γ, x, and uv radiations and the mutagenic action of x and uv radiations in bacteria and viruses. The prevention of the denaturation of DNA is proposed as a means of protection against the harmful effects of radiation. Results are reported from studies on the use of polyanions to prevent DNA denaturation in vitro and in isolated cell nuclei. A number of polyanions were also effective in protecting irradiated animals from the lethal effects of x radiation. It is suggested that stepwise radioinduced denaturation of DNA may be used in combination with chemical mutagens of a definite type for selective action on individual genetic loci for obtaining desired mutations. (C.H.)

**6692** CONNECTION OF RADIOSENSITIVITY OF RATS WITH ANTIOXIDATIVE ACTIVITY OF BONE MARROW AND CONTENT OF UNESTERIFICATED FATTY ACIDS IN THEIR BLOOD UNDER CONDITIONS OF "STRESS." B. V. Leonov, M. A. Lomova, and I. A. Rudakov. Radiobiologiya, 3: 518-22(1963). (In Russian)

A state of stress induced by dosed electrostimulation in rats was shown to induce a decrease in antioxidative activity of the bone marrow and augment the content of unesterified fatty acids in the blood. Possible relations with increased radiosensitivity induced by stress are discussed. It is suggested that the increased expenditure of antioxidants under conditions of stress may be connected with the mobilization of fats from fat depots and that one of the mechanisms of the increase of radiosensitivity under stress conditions may be the result of the oxidation of mobilized lipids. (C.H.)

**6693** ENHANCEMENT OF RADIORESISTANCE OF THE ORGANISM BY A PRELIMINARY IMMUNIZATION WITH BCG VACCINE. N. N. Klemparskaya, N. V. Raeva, and I. N. Usacheva. Radiobiologiya, 3: 557-62(1963). (In Russian)

Experiments in mice, dogs, rabbits, and guinea pigs showed that innoculation with antituberculosis vaccine before irradiation changed the radioresistance of the animals. The degree of radiation protection depended on the species of the animal, dose of vaccine, time interval between vaccination and irradiation, and the combination of immunization with other therapeutic measures. (C.H.)

**6694** REPRODUCING CAPACITY OF MICE IRRADIATED WITH HIGH-ENERGY PROTONS AND PROTECTED BY CHEMICAL AGENTS. S. P. Yarmonenko and V. N. Ivanov (Inst. of Labor Hygiene and Occupational Diseases, Moscow). Radiobiologiya, 3: 576-81(1963). (In Russian)

The reproductive capacity of male mice exposed to 660-Mev protons at doses of 1300 to 1600 rads was restored after 4 to 7 months when the mice were protected with cysteamine, cystamine, AET, 5-methoxytryptamine, or hydroxylamine. No signs of somatic injuries were observed in the first generation offspring of the irradiated males and normal females. (C.H.)

**6695** INFLUENCE OF INTENSITY OF NUCLEIC ACID AND PROTEIN SYNTHESIS UPON LETHAL AND MUTAGENIC EFFECTS OF GAMMA RADIATION. A. G. Skavronskaya, G. E. Fradkin, N. B. Borisova, L. A. Zamchuk, and L. R. Gol'dina (Inst. of Epidemiology and

Microbiology, Moscow). Radiobiologiya, 3: 582-6(1963). (In Russian)

A study was made of the effects of the rate of synthesis of nucleic acids and proteins on the lethal and mutagenic effects of γ radiation in Escherichia coli. When protein and nucleic acid syntheses were blocked, the lethal and mutagenic effects of radiation increased. When cultures were irradiated under conditions that inhibited protein synthesis and slightly stimulated the synthesis of DNA and RNA, a slight decrease was observed in the lethal and mutagenic effects of γ radiation. (C.H.)

**6696** EFFECTS OF PHYTOLIPOPOLYSACCHARIDES AND VB-2 PREPARATION UPON HEMOPOIESIS IN IRRADIATED ANIMALS. V. A. Sondak, E. P. Gracheva, B. N. Gladyshev, and V. I. Suslikov (Inst. of Biology and Physics, and Inst. of Organic Chemistry, Moscow). Radiobiologiya, 3: 587-94(1963). (In Russian)

Injections of lipopolysaccharides (PLP) isolated from tea leaves apparently stimulated bone marrow function in irradiated rats when given 24 to 96 hr before exposure to 700 r γ radiation. The effects were even more marked when a polymer of vinylbutyl ether (VB-2) was given after irradiation to protect intestinal mucosa from radiation injury and to prevent diarrhea induced by whole-body irradiation. Results are reported from extensive blood studies in irradiated rats given PLP injections both before and after irradiation and with the addition of VB-2 treatment. It was concluded that PLP exerts a protective effect upon radiation effects on hemopoiesis and also stimulates erythropoiesis and thrombopoiesis and cells of the leukocyte series. (C.H.)

**6697** CONNECTION BETWEEN RADIOPROTECTIVE AND VASOCONSTRICTIVE ACTION OF INDOLYLALKYLAMINES. P. G. Zherebchenko and N. N. Suvorov. Radiobiologiya, 3: 595-602(1963). (In Russian)

A comparison was made of the radioprotective effects and vasoconstrictive action of a number of indolylalkylamines. The radioprotective action of the amines was determined by effects on the life span of mice exposed to 700 r x radiation and blood loss following a cut in the tail and effects on isolated rabbit ear were used as an index of effects on vascular tone. Data are tabulated on the effects of a number of derivatives and homologs of tryptamine. Good correlation was found between the radioprotective and vasoconstrictive effects of a number of amines of the indole series. Indolylalkylamines having substitutes in the 5th position were found to have a more pronounced vasoconstrictive action than tryptamine and its derivatives. The administration of serotonin antagonists also impeded the vasoconstrictive action of serotonin. (C.H.)

**6698** CHANGES IN CONCENTRATION OF 17-HYDROXYCORTICOSTEROIDS AND HEMATOLOGICAL INDICATORS IN DOGS FOLLOWING APPLICATION OF CERTAIN AGENTS OF CHEMICAL PROTECTION AND IRRADIATION. V. P. Korotkova, V. E. Ryzhenkov, and A. M. Stashkov (Inst. of Experimental Medicine, Leningrad). Radiobiologiya, 3: 603-11(1963). (In Russian)

The concentration of 17-hydroxycorticosteroids (17-HCS) in the blood plasma of dogs exposed to 700 r x radiation showed a decrease during the first 7 post-irradiation days followed by a rise to above-normal concentrations. Marked individual differences were noted in the concentration of 17-HCS as well as in reactions of the adrenal cortex to the injection of ACTH during all periods of radiation sickness. Shielding of the adrenal glands during irradiation and the administration of mercamine and antiffeine before irradiation prevented changes in 17-HCS concentration. It was concluded that the pituitary-adrenal system plays a part in the pathogenesis and pharmacological protection of radiation injuries. Data from blood studies indicated that changes in eosinophils after the administration of ACTH cannot be used to estimate the functional condition of the adrenal cortex in irradiated animals. (C.H.)

**6699** USE OF ALANINE AND PROLINE IN RADIOPROTECTION OF HEREDITARY CELL STRUCTURES OF BONE MARROW IN MAMMALS AGAINST X-IRRADIATION. Yu. M. Rukavishnikov (Novosibirsk Inst. of Cytology and Genetics, Siberian Academy of Sciences, USSR). Radiobiologiya, 3: 612-14(1963). (In Russian)

Alanine and proline given to mice before exposure to x and γ radiation increased the survival time and reduced the number of chromosome aberrations in bone marrow. Possible reaction mechanisms involved are discussed. No toxic effects of alanine and proline were noted at concentrations that afforded radiation protection in mice. It is suggested that these amino acids may afford protection of the hematopoietic system during radiation therapy. (C.H.)

**6700** CORRELATION BETWEEN METABOLIC INTENSITY OF RADIOSENSITIVE ORGAN AND EFFECTIVE DOSE OF RADIOPROTECTOR. K. S. Trincher and A. S. Mozzhukhin (Inst. of Biology and Physics, Moscow). Radiobiologiya, 3: 626-7(1963). (In Russian)

Data are reviewed from a number of studies on the correlation between effective dose of a radioprotective compound and the weight and metabolic activity of various species of mammals or radiosensitive organs in the animals. Calculations were made of the metabolic activity of liver, spleen, brain, and muscle tissues in dogs, cats, mice, rats, and rabbits. The effective radioprotective dose of cysteamine was compared with the metabolic activity of the organs. Good correlation was found between the metabolic activity of spleen and effective radioprotective dose of cysteamine for all the animals studied. It was concluded that the effective dose of a radioprotective agent is directly proportional to the metabolic intensity of radiosensitive organs in the animal. (C.H.)

**6701** DRUG PROTECTION AND EXCRETION OF RADIOISOTOPES FROM ANIMAL BODY FOLLOWING COMBINED EXTERNAL AND INTERNAL IRRADIATION. D. Kraev and Belonski. Voenno Med. Delo, 18: 30-4(1963).

Studies were made on mice irradiated with 550 r and given 1 microcurie of $Co^{60}$ (as $Co^{60}NO_3$) and 1 of $P^{32}$ ($KHP^{32}O_3$) after prophylactic treatment with serotonin (0.85 mg. i.p.), EDTA or both. Serotonin was found to be more effective than EDTA (over half of 20 mice on serotonin survived as opposed to 4 out of 40 untreated controls.) (OTS)

**6702** CHEMICAL PROTECTION OF THE BODY AGAINST IONIZING RADIATION. V. S. Balabukha, ed. Translated by J. T. Greaves from Khimicheskaya Zashchita Organizma ot Ioniziruyushchikh Izluchenii, published by Atomizdat, Moscow, 1960. J. H. Barnes, ed. A Pergamon Press Book. International Series of Monographs on Pure and Applied Biology. Division: Modern Trends in Physiological Sciences. Volume 17. New York, The Macmillan Company, 1963. 174p.

Separate abstracts were prepared for 13 chapters in this book. A combined subject and author index is included in the book. (C.H.)

*For abstracts of individual chapters see: 6608, 6609, 6610, 6611, 6703, 6704, 6705, 6706, 6707, 6708, 6709, 6710, and 6711.*

**6703** PRESENT STATE OF CHEMICAL PROTECTION AGAINST PENETRATING RADIATION. V. S. Balabukha. p.3-10 of "Chemical Protection of the Body Against Ionizing Radiation." New York, The Macmillan Company, 1963.

The search for chemical compounds to protect against the biological effects of ionizing radiation is reviewed. Mechanisms of action of various classes of protective compounds are summarized. It is concluded that all known protective compounds act indirectly through modification of secondary reactions resulting from primary radiochemical processes induced by radiation exposure. (C.H.)

**6704** RELATIONSHIP BETWEEN THE STRUCTURE AND PROPERTIES OF CERTAIN COMPOUNDS CONTAINING SULPHUR AND THEIR PROPHYLACTIC ACTION AGAINST PENETRATING RADIATIONS. V. G. Yakovlev. p.11-38 of "Chemical Protection of the Body Against Ionizing Radiation." New York, The Macmillan Company, 1963.

The prophylactic action of certain compounds containing sulfur against the biological effects of ionizing radiation was investigated in rats exposed to 650 r x radiation. The compounds tested were derivatives of thiazolidine and mercaptopropionic acid, substances of semithioacetal type, salts of esters of cysteine with alcohols, and certain other compounds or combinations of compounds. The protective efficiency of each compound was compared with the properties of the compound. Data are tabulated. Results indicated that the prophylactic effect was based on the chemical, physicochemical, and biological properties of the compound. The most effective compounds contained non-oxidized sulfur, had low molecular weights, and contained free $-SH$ groups or were capable of liberating these groups in living tissues as a result of chemical action with the tissues. The presence of additional functional groups, such as $-NH_2$ or $-CO-NH$, was required, and even a small change in composition and structure affected the radioprotective action of the compound. (C.H.)

**6705** MECHANISM OF THE PROTECTIVE ACTION OF CERTAIN THIOL COMPOUNDS. V. G. Yakovlev and L. S. Isupova. p.39-54 of "Chemical Protection of the Body Against Ionizing Radiation." New York, The Macmillan Company, 1963.

The mechanisms of action of certain nitrogen compounds containing sulfur against the lethal effects of x radiation were investigated in rats. The relation between the degree of protection afforded by the compounds and the concentration of low-molecular-weight SH-compounds in the tissues was studied. The compounds used included both well-known and new ones containing free SH-groups, disulfide and thioether links, and also isothiuronium groupings. The concentration of low-molecular-weight thiol substances in the tissues was judged from the amount of titrated non-protein SH-groups in a non-protein filtrate. A relation was found between the survival rate of the tested animals and the concentration of excess SH-groups in the tissues both during the testing of certain thiolic protective compounds closely related in structure, and also for substances containing different types of non-oxidized organic sulfur linkages. The method of administration and rate of penetration into the organs were found to have a marked effect on the effectiveness of the protective substance. Mechanisms were considered for each group of compounds. Data are tabulated on the protective action on SH-groups in the liver of rats following the intraperitoneal injection of l-cysteine derivatives, cysteamine derivatives, the oral administration of derivatives of l-cysteine and cysteamine, salts of SH-glutathione, derivatives of d,l-methionine, mercaptoacetic acid, unithiol, and inhibitors and stimulators of the protective action of l-cysteine when given intraperitoneally. (C.H.)

**6706** EFFECT OF PROTECTIVE DOSES OF *l*-CYSTEINE ON THE LEVEL OF NON-PROTEIN SULPHYDRYL GROUPS IN THE TISSUES OF RATS EXPOSED TO X-RAYS. L. S. Isupova. p.55-63 of "Chemical Protection of the Body Against Ionizing Radiation." New York, The Macmillan Company, 1963.

The hypothesis concerning the active participation of SH-groups in the primary biochemical reactions that take place in organisms exposed to ionizing radiation is reviewed. Results are reported from a study of the level of non-protein SH-groups in the liver and spleen of rats at various times after the administration of highly purified l-cysteine and exposure to 1,400 r x radiation. It was concluded that the role of sulfhydryl groups in protection against radiation injury needs more study. (C.H.)

**6707** EFFECT OF PROTECTIVE SUBSTANCES ON THE PROTEIN SH-GROUPS IN ORGANS AND TISSUES OF HEALTHY AND EXPOSED ANIMALS. V. G. Yakovlev and L. S. Isupova. p.64-74 of "Chemical Protection of the Body Against Ionizing Radiation." New York, The Macmillan Company, 1963.

The effects of radiation exposure and radioprotective compounds on the content of protein SH-groups were studied in rats. Data on the dynamic equilibrium between the SH-groups of protein and the low-molecular-weight thiols and disulfides in tissue fluids are reviewed. Results are reported from measurements of the effects of l-cysteine and cysteamine on the levels of non-protein and total protein SH-groups in the liver and testis tissues of non-exposed rats and rats exposed to 650 r x radiation. It is concluded that in the mechanism of the radioprotective action of aminothiols and SH-amino acids an important part is played by the reaction of these compounds with the reactive parts of the proteins, purine and pyrimidine bases, and other biomolecules. (C.H.)

**6708** SYNTHESIS AND TESTING OF THE PROTECTIVE ACTION OF A NUMBER OF SULPHUR-CONTAINING COMPOUNDS AND DERIVATIVES OF COUMARIN. V. G. Yakovlev and V. S. Mashtakov. p.75-85 of "Chemical Protection of the Body Against Ionizing Radiation." New York, The Macmillan Company, 1963.

Organic nitrogen thiocompounds, sodium salts of polythionic acids, derivatives of coumarin, and its sulfur-containing analogs were synthesized and tested for their radioprotective effects in rats exposed to doses of 600 to 650 r x radiation. None of the compounds had protective properties. (C.H.)

**6709** EFFECT OF $\beta$-MERCAPTOETHYLAMINE ON THE FORMATION OF ORGANIC PEROXIDES IN THE IRRADIATED ANIMAL. E. F. Romantsev and Z. I. Zhulanova. p.86-96 of "Chemical Protection of the Body Against Ionizing Radiation." New York, The Macmillan Company, 1963.

Studies in mice exposed to 1,000 r x radiation showed that $\beta$-mercaptoethylamine (MEA) caused a reduction in the amount of organic peroxides formed during radiation exposure. Implications of the findings in explaining the radioprotective effects of MEA are discussed. (C.H.)

**6710** POSSIBILITY OF USING CHEMICAL COMPOUNDS AS TRAPS FOR ENERGY IN PROTECTION AGAINST PENETRATING RADIATIONS. G. E. Fradkin.

p.97-114 of "Chemical Protection of the Body Against Ionizing Radiation." New York, The Macmillan Company, 1963.

Initial processes in the development of radiation injuries in living organisms are reviewed. Emphasis is placed on radiation effects on the metabolism of nucleic acids and proteins. It is postulated that chemical traps for energy may decrease the extent of the photochemical reactions of radiation that damage nucleic acids. Results are reported from studies of the comparative protective action of several chemical compounds in mice and rats exposed to doses of 650 r $\gamma$ radiation. The compounds used were $\beta$-mercaptoethylamine and certain derivatives of pyrimidine bases. Results showed that chemical compounds that have a clearly pronounced property of absorbing the energy of electromagnetic radiations in the ultraviolet region of the spectrum, corresponding to the absorption of nucleic acids, give a small protective effect when injected into animals before they are exposed to $\gamma$ radiation at lethal dose ranges. It was also shown that the presence of SH-groups in the molecule is not obligatory for chemical compounds of the pyrimidine series to show a protective effect. (C.H.)

**6711** PHYSICO-CHEMICAL (CHROMATOGRAPHIC) STUDY OF THE EFFECTIVENESS OF CERTAIN COMPLEXING AGENTS. L. I. Tikhonova and L. M. Razbitnaya. p.119-24 of "Chemical Protection of the Body Against Ionizing Radiation." New York, The Macmillan Company, 1963.

The effectiveness of over 20 complexing agents in the removal of $Sr^{89}$, $Sr^{90}$, $Y^{91}$, $Po^{210}$, and $Zr^{95}$ from the body was investigated by means of a chromatographic method that indicated the stability of complexes formed after conversion of the cationic form of the stable element to the ionic form in a cation exchange column. It was pointed out that there is danger of these elements entering the human body since they are widely used in research and by industry. Each of the elements has a different capacity for complex formation. Complexing agents must be nontoxic, must form water-soluble complex compounds with the radioactive isotope, must be readily diffusible, and must be stable under physiological conditions. Results indicate that more stable complexes are formed by Y with cyclohexanediaminetetraacetic and cyclopentanediaminetetraacetic acids; by Po with unithiol, and cyclopentane-, ethylene-, and cyclohexanediaminetetraacetic acids; by Zr, an analog of Pu, with cyclopentane-, cyclohexane-, ethylenediaminetetraacetic and uramildiacetic acids; and by Sr with cyclohexane-, cyclopentane-, and ethylenediaminetetraacetic acids. However, the removal of Sr isotopes from the body is complicated by the fact that Ca is a competitor of Sr. (C.H.)

## Radiation Hazards and Protection

**6712** (DPSPU-63-30-42) RADIOACTIVE WASTE: RADIATION-PROTECTION STANDARDS AND CATEGORIZATION. W. C. Reinig (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.). Dec. 1963. Contract AT(07-2)-1. 11p. (CONF-367-1)

From Annual Meeting of the National Technical Task Committee on Industrial Wastes, St. Louis, Mo., Dec. 1963.

Hazards from the discharge of radioactive wastes to the environment are reviewed. It is pointed out that more is known today about the effects of ionizing radiation than about many other noxious materials that man has introduced into his environment. The formulation of radiation protection standards is reviewed. It is postulated that these standards will be relaxed or tightened as more knowledge becomes available about the behavior of radionuclides in the environment and the biological effects of low levels of long-continued irradiation. (C.H.)

**6713** (IA-821) CLASSIFICATIONS OF RADIONUCLIDES ACCORDING TO MAXIMUM PERMISSIBLE BODY BURDENS. Recompilation of Data. Y. Feige and P. Gairon (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). Feb. 1963. 14p.

Radioisotopes are classified as to maximum permissible body burden expressed as activity, as weight, and as the number of atoms. The significance of the classification in determining the toxicity of the isotopes is discussed. (C.H.)

**6714** (ORNL-3499(Vol.II)(p.56-60)) CALCULATION OF DOSE IN TISSUE DUE TO NUCLEONS BELOW 400 Mev. W. E. Kinney and C. D. Zerby (Oak Ridge National Lab., Tenn.).

The average whole-body dose in an infinite slab of tissue 30 cm thick due to 100-, 200-, 300-, and 400-Mev nucleons both normally and isotropically incident on the slab were calculated. For all cases of incident protons, the primary proton beam is the main contributor to the dose, although for an incident energy of 400 Mev the rem dose due to heavy secondary particles amounts to as much as 69% of the normally incident primary dose and the secondary proton dose amounts to 43% of the primary dose. At 100 Mev the rem dose due to secondaries is only one-sixth the normally incident primary rem dose. At 400 Mev the dose from secondary radiation at a 400-Mev incident energy is about the same for both incident neutrons and incident protons. Flux-to-dose conversion factors are presented for all cases considered. (auth)

**6715** (ORNL-3499(Vol.II)(p.85-9)) ABSORBED DOSE IN A WATER-FILLED SPHERICAL PHANTOM DUE TO 14-Mev AND Po–Be NEUTRONS. T. V. Blosser and R. M. Freestone, Jr. (Oak Ridge National Lab., Tenn.).

A small ethylene-filled ionization chamber was used to measure the depth-dose distribution within a water-filled 42-cm-diameter spherical Lucite phantom resulting from a beam of 14.1-Mev neutrons and from the neutron spectrum of a Be–Po source. The results are compared with previous depth-dose curves resulting from exposure of the phantom to the nuclear secondaries from aluminum targets in a 160-Mev proton beam. (auth)

**6716** ON THE DOSIMETRY OF SOLAR PROTON RADIATION FIELDS IN SPACE. Hermann J. Schaefer (Naval School of Aviation Medicine, Pensacola, Fla.). Biophysik, 1: 167-74(1963). (In German)

In the wake of large chromospherical eruptions of the sun large increases in the proton flux in the whole interplanetary space appear. In the region of the earth the formation and decay of such solar proton fields follow very complicated laws. Comparative measurements of a series of large eruptions allowed the formulation of a "synthetic" maximal event, which permitted the calculation of dose rates and total dose and of depth distributions in a tissue phantom. The results of such calculations are presented. They show the great variations to which the dose rate and dose depth are subject in the course of time. Estimation of the daily radiation burden from such total-body irradiation with great variations did not appear possible. (tr-auth)

**6717** MEASUREMENT OF RADIOACTIVE CONTAMINATION BY WHOLE BODY SPECTROMETRY. J. F.

Colard, R. R. Boulenger, J. A. Henry, and W. G. Verly (Centre d'Étude de l'Énergie Nucléaire, Mol, Belg.). Health Phys., 10: 15-23(Jan. 1964).

A whole-body counter is described that was used to measure contamination levels of persons over the past 3 yr. The results from 2,600 measurements are discussed. The evolution of the mean $Cs^{137}$ body burden activity, from 1959 to date, is reported. The first results of a study on $I^{131}$ metabolism in order to evaluate the hazards of I contaminations are given. For continuous exposure the amounts of $I^{131}$ activity in the thyroid and in the rest of the body are in the ratio 86:14, implying a maximum permissible body burden of 0.16 $\mu$C $I^{131}$. (auth)

**6718** RADIATION EXPOSURE RECORDS. Hanson Blatz (Office of Radiation Control, New York). Health Phys., 10: 30(Jan. 1964).

The use of film badge data to establish radiation exposure dose is discussed. (C.H.)

**6719** ABSOLUTE REPRESENTATION OF THE ROENTGEN UNIT IN THE $Co^{60}$ GAMMA-RAY ENERGY INTERVAL BY MEANS OF CAVITY IONIZATION CHAMBERS. A. Rakow and W. Will (Institut für Biophysik der Forschungsgemeinschaft der Naturwissenschaftlichen, Technischen und Medizinischen Institute, Berlin). Kernenergie, 6: 546-52(Oct. 1963). (In German)

The description of a method for the absolute representation of the roentgen unit in the $Co^{60}$ gamma energy interval is continued. The irregularities in photon intensity at the place of measurement in the cavity ionization chamber, saturation, air density, air moisture, corrections, errors in verification of the roentgen unit, and results are discussed. (M.C.G.)

**6720** MORPHOLOGICAL CHANGES IN RATS AFTER INTRATRACHEAL INTRODUCTION OF VARIOUS IRON-59 COMPOUNDS. N. D. Sagaidak. Materialy po Toksikol. Radioaktivn. Veshchestv, Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR, No. 3, 131-46(1962). (In Russian)

Injury to the respiratory system by $Fe^{59}$ was investigated by determining the nature of pathologic anatomical changes in animal organisms after introducing various $Fe^{59}$ compounds into the lungs and estimating the internal dose which leads to the development of malignant tumors in the pulmonary tissue. Up to 12% of the activity of the $Fe^{59}$ preparations was due to admixtures of $Co^{60}$; this fact was taken into account in the calculation of tissue dose. The radiotoxic effects were followed for periods up to 15 months. Preparations of $Fe^{59}$ citrate or oxide with activities of 27.5, 3.36, and 1.06 $\mu$C were administered once and 0.03 $\mu$C three times to white rats. The largest amount led in many cases to the development of purulent inflammatory processes in the bronchia with sclerotic changes in the peribronchial tissue. The largest amount introduced exceeded the MPC value by a factor of 250 and resulted in increased mortality, attributable in most cases to malignant tumors in the lungs. Lung cancer was noted 6 months after the introduction of $Fe^{59}$, corresponding to a relatively low-level irradiation of the pulmonary tissue, ranging from 480 to 9790 rads. Treatment with 0.03 $\mu$C of $Fe^{59}$ 3 times, corresponding to the MPC value, caused purulent changes in the pulmonary tissue. These data, indicating a marked carcinogenic activity of $Fe^{59}$, may be used for determining the permissible levels of insoluble $Fe^{59}$ compounds in the air. (TTT)

**6721** RADIOAKTIVE ISOTOPE IN FUTTER- UND NAHRUNGSMITTELN. (Radioactive Isotopes in Fodder and Foodstuff). Friedrich Ludwieg. Thiemig-Taschenbucher, Band 7. Munich, Verlag Karl Thiemig KG, 1962. 151p.

Investigations of food and fodder for radioactivity are discussed. Topics covered include: sources of radioactivity, radioisotopes in the biosphere, radiation from radioisotopes measuring instruments for detection of radiation, determination of beta activity of plants, determination of alpha activity, radiochemical analytical methods for individual radioisotopes, gamma spectrometry for detecting radioisotopes, and the problem of maximum permissible concentration of radioisotopes in food. (M.C.G.)

## Radiotherapy and Radiodiagnosis

**6722** (TID-19837) DEVISING TECHNIQUES UTILIZING THE DIFFERENTIAL UPTAKE OF RADIOACTIVE PHOSPHORUS FOR IN VIVO DETECTION OF OCCULT OR SILENT GASTRIC CANCER AND FOR MULTIPLE ORGAN SCREENING. Final Report. Norman B. Ackerman (Minnesota. Univ., Minneapolis). [nd]. Contract AT(11-1)-897. 15p.

Applications of the differential uptake of $P^{32}$ by tumor tissues in the detection of cancer are described. The method gave good results in the location of thyroid cancers but was less successful in the localization of breast cancers, and was found to be unreliable in patients with enlarged axillary nodes. The method gave good results when combined with in vivo radioautography for the diagnosis of several malignant conditions, especially carcinoma of the stomach. The preparation of balloon radioautographs using a thin-walled balloon made of rubber or elastic polyurethan coated with a photographic emulsion to determine the uptake of $P^{32}$ in gastric tumors is described. Results are summarized for a group of patients. A modification of the technique, in which patients with carcinoma of the colon swallowed a small capsule containing a photosensitive emulsion after receiving $P^{32}$, was not successful. Radioautographic techniques were also used on patients with cancers of the skin, breast, cervix, and bladder after the administration of $P^{32}$. The advantages of this method over the usual surface counting methods are discussed. (C.H.)

**6723** (NP-tr-1080) HYPOPHYSECTOMY BY MEANS OF RADIOACTIVE ISOTOPES IN THE TREATMENT OF METASTASIZED MAMMARY CANCERS. J. Gary-Bobo and J. Belotte. Translated by P. E. Crampton (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from J. Radiol. Electrol. Med. Nucl., 41: 242-6 (1960). 15p. (Includes original, 3p.). (Handwritten MS copy.)

Results are reported for 12 breast cancer patients with metastases treated using $Y^{90}$ hypophyseal implants. The procedure used and clinical results are described. Improvements were noted in 40% of the cases. (C.H.)

**6724** (NP-tr-1081) TECHNIQUES AND DOSIMETRY IN INTERSTITIAL RADIOTHERAPY WITH GOLD-198 SEEDS. J. Dutreix. Translated by P. E. Crampton (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.), from J. Radiol. Electrol. Med. Nucl., 42: 228-36(1961). 34p.

A technique is described for the implantation of $Au^{198}$ seeds in interstitial tumor therapy. Dosimetry tables are included. (C.H.)

**6725** RADIATION FOR THERAPY—IN RETROSPECT AND PROSPECT. John G. Trump (Massachusetts Inst. of Tech., Cambridge). Am. J. Roentgenol., Radium Therapy Nucl. Med., 91: 22-30(Jan. 1964).

Progress in the development of equipment and techniques for radiotherapy during the past 30 years is reviewed. Emphasis is placed on the development of megavolt generators. (C.H.)

**6726** HYPERFRACTIONATION. Francois Baclesse (American Hospital of Paris, Paris). Am. J. Roentgenol., Radium Therapy Nucl. Med., 91: 32-6(Jan. 1964).

The hyperfractionation method, with high total doses, has the advantage that, besides the direct cellular action, there is an action on the surrounding vasculoconnective tissues which has very important consequences in the post-irradiation period. This fact is well proved by late resorption of certain tumors, sometimes occurring long after treatment, and is the main cog in the rationale of hyperfractionation with high total doses. The high total dose is necessary for the control of the cancer cells which are sometimes radioresistant. The hyperfractionation is necessary to preserve the surrounding tissue, the protection of which is essential from the radiobiologic point of view. With this method much better results are also obtained when preoperative irradiation with high doses is given. This is especially true if high energy radiation, such as $Co^{60}$ teletherapy is used. (auth)

**6727** SPLIT-COURSE RADIATION THERAPY IN MALIGNANT TUMORS. D. K. Sambrook (Swansea Hospital, South Wales, Eng.). Am. J. Roentgenol., Radium Therapy Nucl. Med., 91: 37-45(Jan. 1964).

The advantages of fractionated dose for radiotherapy are discussed. (C.H.)

**6728** REDUCED FRACTIONATION IN RADIATION THERAPY. Charles Botstein (Montefiore Hospital, New York). Am. J. Roentgenol., Radium Therapy Nucl. Med., 91: 46-9(Jan. 1964).

Spaced fractions of radiation dose offer the advantages of better tumor response, better general tolerance of the treatment by the patient, and convenience to the patient through reduction of weekly visits, often enabling him to pursue his occupation and in some instances making hospitalization unnecessary. (auth)

**6729** MASSIVE SINGLE DOSE, WEEKLY FRACTIONATION TECHNIQUE IN TREATMENT OF HEAD AND NECK CANCER. PRELIMINARY REPORT. Harold L. Atkins (Brookhaven National Lab., Upton, N. Y.). Am. J. Roentgenol., Radium Therapy Nucl. Med., 91: 50-60(Jan. 1964).

A series of patients treated on a once-a-week irradiation schedule with supervoltage equipment is presented. The feasibility of this treatment schedule was demonstrated. Complications were at an acceptable level and short-term results indicate a favorable response. Several advantages of the method are considered. Further study is necessary before the method can be accepted on more than an experimental basis. (auth)

**6730** RESULTS OF ULTRAFRACTIONATION RADIATION THERAPY IN BREAST CARCINOMA. M. Archambault, M. L. Griem, and D. J. Lochman (Univ. of Chicago; Argonne Cancer Research Hospital, Chicago; and Columbus Hospital, Chicago). Am. J. Roentgenol., Radium Therapy Nucl. Med., 91: 62-6(Jan. 1964).

A group of 168 patients with breast carcinoma was given radiation therapy by an ultrafractionation technique following radical mastectomy where residual regional disease was suspected or proven. The overall survival rate at 5 yr was 54.3%. Cutaneous recurrence on the chest wall was noted in 4.2% and regional lymph node recurrence in 1.7% of the patients. These figures are more favorable than those reported when surgery alone was used and comparable to the results obtained with short courses of radical radiation therapy. Morbidity was appreciably less and patient comfort considerably greater than reported in patients given short courses of radical radiation therapy. (auth)

**6731** THE INFLUENCE OF TIME-SPACING OF FRACTIONS ON RESPONSE TO RADIATION. Lucille A. Du Sault (Henry Ford Hospital, Detroit). Am. J. Roentgenol., Radium Therapy Nucl. Med., 91: 90-4(Jan. 1964).

Spontaneous mammary adenocarcinomas in $C_3H$ mice were irradiated with 12 × 667 r to 8,000 r in 25 days with different spacings of the treatments within this time period. Results showed that gaps between treatments which occur early in the treatment series will harm cure rates more than if they occur late in the series and that the decrease in cure rate increases, although not proportionally, with length of the gap. (auth)

**6732** AN AFTER-LOADING SYSTEM UTILIZING CESIUM 137 FOR THE TREATMENT OF CARCINOMA OF THE CERVIX. Harry Horwitz, James G. Kereiakes, Gustave K. Bahr, Sue E. Cluxton, and Charles M. Barrett (Univ. of Cincinnati). Am. J. Roentgenol., Radium Therapy Nucl. Med., 91: 176-91(Jan. 1964).

A complete system is presented for the intracavitary treatment of carcinoma of the cervix using $Cs^{137}$ instead of Ra and incorporating several novel features. The system uses an after-loading device which is disposable, and which can incorporate effective Pb shielding for the rectum and/or bladder. The only permanent equipment is a small mobile Pb safe containing sealed source cartridges, and thus the armamentarium required for carrying out the treatment is minimal and relatively inexpensive. Moreover, special facilities such as a radium room with all its associated equipment are not needed. Sterile packages of disposable plastic applicators can be purchased as required. The method is thus quite suitable for use in smaller hospitals where perhaps the case load is not great, and space and money are limited. Some aspects of $Cs^{137}$ for intracavitary use are discussed and some preliminary data and calculations on $Cs^{137}$ dosimetry are presented. The principal virtues of the system described are that it is inexpensive, easy and flexible in use, and that it reduces to an unprecedented minimum both work and radiation exposure for therapist, technicians and nurses. (auth)

**6733** THE PREPARATION OF RADIOACTIVE CHEMICALS FOR CLINICAL USE. William H. Briner (Public Health Service, Bethesda, Md.). Atomlight, No. 34, 1-10(Dec. 1963).

Problems encountered in the preparation of radioactive chemicals for clinical use are reviewed. The importance of quality control in the preparation of radioactive pharmaceutical preparations is stressed. Topics discussed include the elimination of pyrogens, the importance of chemically clean glassware, formulation controls, the purity of chemicals, solvent systems for products intended for intravenous administration, the use of additives, clarification, sterilization, packaging, and biological control testing. (C.H.)

**6734** ON THE CALCULATION OF THE INTEGRAL ABSORBED DOSE IN IRRADIATION THROUGH A SCREEN. R. G. Mamin. Med. Radiol., 8: No. 11, 64-6(Nov. 1963). (In Russian)

Data are presented revealing that the dose of scattered radiation measured in a phantom outside the volume irradiated by a direct beam through a screen is equal to the dose

of scattered radiation from the field the area of which is equal to the area of the open sections of the screen. It is proposed that in x irradiation through a lead lattice the integral absorbed dose in a patient's body be approximately calculated with the same method as would be employed when using the open field the area of which is equal to the total area of the sections of the screen. (auth)

**6735** A COMPLEX AND FUNCTIONAL DESIGN FOR PROTECTION IN RADIOLOGICAL DEPARTMENTS USING CLOSED $\gamma$ EMITTERS. A. M. Levit. Med. Radiol., 8: No. 11, 67-73(Nov. 1963). (In Russian)

Descriptions are given of efficient design and operation of radiological departments in Oncological Research institutes. The construction of the building, and equipment and storage facilities offer maximum shielding and protection to the personnel and patients in the research wards. A complex territorial and functional design is given for efficient time saving and safe technological procedures. (R.V.J.)

**6736** OPTIMIZATION OF A SCANNING METHOD USING $Tc^{99m}$. P. V. Harper, R. Beck, D. Charleston, and K. A. Lathrop (Argonne Cancer Research Hospital, Chicago). Nucleonics, 22: No. 1, 50-4(Jan. 1964).

Description is given of how $Tc^{99m}$ picked from the chart because of its desirable physical characteristics was manipulated to make its biological characteristics sufficiently favorable so that the overwhelming advantages accruing from its physical parameters may be enjoyed in a variety of ways. Biological and physical factors, including uptake, localization, radiation dosage, energetics, and collimation, are discussed. Thyroid, lateral, and liver scans with $Tc^{99m}$ are illustrated. (P.C.H.)

**6737** BIOLOGICAL ASPECTS IN THE CHOICE OF SCANNING AGENTS. Monte Blau and Merrill A. Bender (Roswell Park Memorial Inst., Buffalo). Nucleonics, 22: No. 1, 55-7(Jan. 1964).

The biological properties of agents used in several typical scanning procedures, both routine and experimental, are discussed. Methods used for scanning of the brain, kidney, liver, spleen, pancreas, bone, thyroid, heart, and tumors are reviewed. (P.C.H.)

**6738** STUDYING ORGAN CIRCULATION, FUNCTION AND STRUCTURE WITH RADIOISOTOPES. George V. Taplin (Univ. of California, Los Angeles and Los Angeles County Harbor General Hospital, Torrance, Calif.). Nucleonics, 22: No. 1, 58-60(Jan. 1964).

Methods performed externally following intravenous injection of organ-specific gamma-emitting radioisotopes with sensitive scintillation detector-recorder systems that permit continuous registration of the tracer material as it enters and leaves internal organs are described. The external monitoring techniques allow assessment of organ blood supply and specific functions with relative simplicity and safety. Recent developments concerning radioisotopes in kidney disease and hypertension are reviewed in depth. (P.C.H.)

# CHEMISTRY

## General

*Refer also to abstract 7853.*

**6739** (NP-13417) ON HOMOGENEOUS FLUIDIZATION. I. A KINETIC THEORY OF THE HOMOGENEOUS FLUIDIZED BED. II. THE AXIAL MIXING COEFFICIENT IN A HOMOGENEOUS FLUIDIZED BED. E. Ruckenstein (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). [1962]. 33p.

A kinetic theory of the homogeneous fluidized bed is developed which provides information on the mixing process as well as on the physical properties of the bed. The physical model of the fluidized bed is discussed. Energy dissipation in the motion of the solid particles and the dynamics of the motion are considered. Finally, the kinetic theory is used to point out a possible mechanism for axial mixing (diffusion) within the fluidizing agent and to derive equations for the axial mixing coefficient. (D.L.C.)

**6740** A NEW FORM OF THE PERIODIC SYSTEM OF THE ELEMENTS. Torolf Ternstroem (Kungl. Patent- & Registreringsverket, Stockholm). Svensk Kem. Tidskr., 75: 579-83(1963). (In Swedish)

A new form of the periodic system of the elements, based upon the Werner-block- and a horizontal Bohr-line-system, is proposed. The vertical lines in the latter system were replaced by blocks and the right hand sloping lines raised to the right. The new system also includes a special line-system, a 0(zero)-period with neutrino, new group designations and a new C-group-arrangement. (auth)

## Analytical Procedures

**6741** (AERE-R-4460) THE DETERMINATION OF RADIUM-228 IN HARWELL EFFLUENT. W. M. Henry, B. A. Loveridge, and J. R. Weaver (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Dec. 1963. 23p.

Radium is recovered from an aliquot of effluent by coprecipitation with lead and barium sulfates. The precipitate is dissolved in an alkaline solution of ethylenediaminetetraacetic acid and the barium–radium sulfate is reprecipitated by careful adjustment of the acidity. Following metathesis to the carbonate and solution in dilute acid, the barium–radium solution is fed to a heated column of ion exchange resin. The radium is eluted free from barium carrier, with 0.5 M citric acid adjusted to pH 6 with ammonia. The actinium-228 daughter is permitted to grow in the radium fraction of the eluate before being extracted with di-(2-ethylhexyl) hydrogen phosphate. The recovered actinium is purified by further ion exchange separations and then beta counted. The analytical procedure is standardized against a solution of natural thorium containing a known quantity of radium-228. (auth)

**6742** (IDO-14623) DETERMINATION OF PICRIC ACID AND MONONITROPHENOLS IN ICPP PROCESS SOLUTIONS. Stanley S. Yamamura and John H. Sikes (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Oct. 1963. Contract AT(10-1)-205. 13p.

The presence of nitrophenols in the Idaho Chemical Processing Plant first cycle process solutions presented a possible hazard during evaporations. Picric acid, selected as an index of the hazard, has been determined with a precision of 3.1% relative standard deviation. The picric acid is extracted selectively from acidic medium into 2-ethyl-1-hexanol then measured photometrically as the yellow picrate ion at 353 mμ. Mononitrophenols also are separated by extraction and measured photometrically at 412 mμ. In the presence of citrate at pH 5 to 6, the coextraction of nitrate, picric acid, and uranium(VI) is nil. (auth)

**6743** (LAMS-2988) THE DIFFERENTIAL THERMAL ANALYSIS UNIT AT GROUP GMX-3. Stanley V. Dubiel, Jr. and John F. Baytos (Los Alamos Scientific Lab., N. Mex.). May 31, 1963. Contract W-7405-eng-36. 59p.

A custom-made instrument for differential thermal analysis (DTA) of explosive materials was designed and built for routine operations at Group GMX-3. This compact model is based on the prototype developed by R. N. Rogers, Group GMX-2, who adapted DTA to explosive materials. DTA thermograms are obtained with this apparatus on very small samples, which reduces the explosion hazard. The main feature of the apparatus is an expendable furnace assembly contained in a blast-shielded drawer. This drawer, the programmer, the thermocouple reference, the microvolt amplifier, and the X-Y recorder are assembled into a relay rack for ease of operation by the analyst. Calibration of the axes is described, and a simplified procedure is developed for the accurate recording of DTA thermograms on a preprinted chart. Irregularities caused by faulty components and manipulative technique are discussed, and recommended methods are given to remedy each situation. The appendixes contain a formal procedure for the operation of this instrument with illustrations of the apparatus, schematic diagrams, graphs of temperature vs millivolt output, and typical DTA thermograms produced by this instrument. (auth)

**6744** (NBL-198) AN AUTOMATIC FUEL ELEMENT ENRICHMENT DIFFERENTIATOR (FEED) BASED ON GAMMA-RAY SPECTROMETRY. L. C. Nelson, Jr., S. J. Lorik, H. Bussell, and C. L. Zyskowski (New Brunswick Lab., AEC, N. J.). Aug. 1963. 11p.

An automatic fuel element enrichment differentiator (FEED) system was developed which utilizes a single-channel pulse height analyzer measuring the 0.184 Mev gamma ray of $U^{235}$ to differentiate between fuel elements of 0.72 and 0.94 wt % $U^{235}$, and a relay-meter read-out to determine if the fuel element is within an acceptable range The system can scan a fuel element in about 20 seconds and differentiate with an error of 0.66 fuel elements per hundred. (auth)

**6745** (NSEC-88) SURVEY OF IODINE-129 CONCENTRATIONS IN THYROID TISSUES. Progress Report. (Nuclear Science and Engineering Corp., Pittsburgh). Mar. 4, 1963. Contract AT(30-1)-3049. 19p.

Progress is reported in a survey of $I^{129}$ concentrations in human and other mammalian thyroid tissues collected at times varying from 1930 to 1963. Neutron activation analysis, leading to the formation of $I^{130}$, was used to determine $I^{129}$ concentrations. The experimental procedure is described in detail. Results are reported for 9 whole human thyroid glands and 4 samples of desiccated hog thyroid. Results indicate geographical variations and a biospheric increase in $I^{129}$ content from 1957 to 1962. (C.H.)

**6746** (ORNL-3528) ISOTOPIC MASS SPECTROMETRY OF THE ELEMENTS. E. J. Spitzer and J. R. Sites, comps. (Oak Ridge National Lab., Tenn.). Dec. 17, 1963. Contract W-7405-eng-26. 83p.

The Analytical Mass Spectrometry Section at Oak Ridge National Laboratory has, for many years, been determining relative isotopic abundances from solid samples. Thus, useful analytical mass spectrometer experience with every pertinent element has been obtained. These include the 55 polyisotopic elements as well as products of irradiation and fission. The techniques used are summarized in this report. A separate page for each element lists preferred compound, loading of sample, manner of obtaining a stable ion beam, and solutions of special problems. (auth)

**6747** (CEA-tr-A-1396) ANALYSE PAR ACTIVATION NEUTRONIQUE DE SUBSTANCES ABSORBANT FORTEMENT LES NEUTRONS. (Analysis by Neutron Activation of Substances Strongly Absorptive of Neutrons). F. Baumgaertner. Translated into French from Z. Elektrochem., 64: 1077-80(1960). 17p.

Neutron activation analysis is useless for the determination of small quantities of chemical elements in substances that are strongly neutron-absorbing, because the activation of the strong absorber masks the activity to be determined. A method is presented for removing this difficulty. In the method, a filter, made of the same neutron-absorbing substance as that containing the element to be determined, is interposed between the beam and the target. This filter absorbs practically all the neutrons that would otherwise be absorbed by the substance to be analyzed; practically all activity in the target is therefore induced in the element to be determined. (T.F.H.)

**6748** CONTROLLED POTENTIAL COULOMETRY OF METALS IN FUSED LITHIUM CHLORIDE–POTASSIUM CHLORIDE EUTECTIC. Roy D. Caton, Jr. and Harry Freund (Oregon State Univ., Corvallis). Anal. Chem., 36: 15-19(Jan. 1964).

The controlled potential coulometric determination of platinum, copper, chromium, and vanadium in fused lithium chloride–potassium chloride eutectic was studied. Platinum(II) was determined with a relative error of 0.67% by plating out the metal, and copper(II) with a relative error of 0.45% both by deposition of the metal and by stripping from graphite or platinum electrodes. Chromium was determined with a relative error of 0.38% by reduction of chromium(III) to chromium(II), and vanadium with a relative error of 1.0% by oxidation of vanadium(III). Using a coulometric procedure, the standard electrode potentials of the vanadium(III)–vanadium(II) and chromium(III)–chromium(II) systems were determined in solutions ranging from 0.016 to 0.04M. Polarograms of niobium solutions made by anodizing the metal in the melt exhibited two waves. Coulometric and polarographic data indicated that the solutions contained niobium(IV) and niobium(III) in a concentration ratio of 3 to 1. (auth)

**6749** CATHODIC ACTION OF THE URANYL-ITACONATE COMPLEX AT THE DROPPING MERCURY ELECTRODE. Tsai-teh Lai and Be-cheng Wang (Cheng Kung Univ., Tainan, Taiwan, China). Anal. Chem., 36: 26-8(Jan. 1964).

The uranyl-itaconate complex was studied polarographically. From the potential and current data the existence of a mixture of monomer and polymer, having the chelate species of $(UO_2A_2^{-2})_n$ $(n = 1 \sim 3)$ and $(UO_2A^{-1})_{n'}$ $(n' = 1 \sim 2)$, were identified. The electrode reactions in three ranges of pH value were given and the influence of pH and uranyl ion concentration on the character of waves is discussed. (auth)

**6750** AMPEROMETRIC TITRATION OF URANIUM(IV) WITH CERIUM(IV) UTILIZING PYROLYTIC GRAPHITE ELECTRODE. H. E. Zittel and F. J. Miller (Oak Ridge National Lab., Tenn.). Anal. Chem., 36: 45-7(Jan. 1964).

A method was developed for the direct amperometric titration of uranium(IV). The pyrolytic graphite electrode is used as the indicator electrode and $Ce(HSO_4)_4$ is used as the titrant. Applied potentials of from +1.0 to 0.0 volt vs the SCE may be used, with the more positive potentials being preferred. The method has a maximum relative error of ±1.12% over the concentration range from 0.05 to 10 μg of U(IV) per ml. Few of the common ions interfere and the method is simple and straightforward. (auth)

**6751** BEHAVIOR OF TECHNETIUM SPECIES WITH CUPFERRON. G. B. S. Salaria, Charles L. Rulfs, and Philip J. Elving (Univ. of Michigan, Ann Arbor). Anal. Chem., 36: 146-9(Jan. 1964).

Evidence is given for the formation of a pertechnetate adduct with cupferron in acidic media. No indication was found for significant technetium(IV) reactivity, but a technetium(III) cupferrate does exist. Liquid-liquid extraction, supplemented by polarographic study, provides the principal evidence for the conclusions. A concentration or partial separation of pertechnetate from perrhenate is possible using cupferron and chloroform extraction. (auth)

**6752** SELECTIVE DETERMINATION OF MERCURY BY ISOTOPIC EXCHANGE WITH MERCURIC Di-n-BUTYL PHOSPHOROTHIOATE IN AN EXTRACTION SYSTEM. ALTERNATIVE DISPLACEMENT METHOD WITH SILVER Di-n-BUTYL PHOSPHOROTHIOATE. Thomas H. Handley (Oak Ridge National Lab., Tenn.). Anal. Chem., 36: 153-6 (Jan. 1964).

A rapid and precise isotopic-exchange method was developed for the determination of $10^{-7}$ to $10^{-2}$ gram of mercury; a solvent extraction technique is used. The organic phase is a $CCl_4$ solution of mercuric di-n-butyl phosphorothioate; the aqueous phase is a mineral-acid solution (≥0.2N) of the sample. The $Hg^{2+}$ of the mercuric di-n-butyl phosphorothioate exchanges with the $Hg^{2+}$ of the sample. The $D_{Hg}$ is measured by means of $Hg^{203}$, either added as a tracer to the aqueous phase or incorporated as a label in the mercuric di-n-butyl phosphorothioate. A simple proportional relationship exists between $D_{Hg}$ and mercury concentration. The analysis of standard solutions of $Hg^{2+}$ gave results within 99 to 101% of the known $Hg^{2+}$ concentrations; the standard deviation was about 1%. In an alternative method, the extractant is silver di-n-butyl phosphorothioate. The $Ag^+$ in the complex is displaced by an equivalent amount of $Hg^{2+}$ from the sample, and $Ag^{110}$ is exchanged with inactive silver. (auth)

**6753** DETECTION OF SUBMICROGRAM AMOUNTS OF FLUORIDE ON THE RING OVEN WITH THORIUM CHLORANILATE. J. E. Barney II (Midwest Research Inst., Kansas City, Mo.). Anal. Chem., 36: 247-8(Jan. 1964).

A method is described for the determination of submicrogram amounts of fluoride using the ring oven and thorium chloranilate as the reagent. As little as 0.1 μg of fluoride as sodium fluoride can be detected by the method. A semiquantitative relationship was noted between intensity of the color of the ring and amount of fluoride in the range of 0.1 to 1.0 μg of fluoride. The method is simple and rapid, and it has sufficient sensitivity for many applications. (P.C.H.)

**6754** SPECTROGRAPHIC ANALYSIS OF SOME RADIOACTIVE MINERALS. C. Ruscior, N. Calinicenco,

Gh. Tacu, and Marcel Moise. Bull. Inst. Politeh. Iasi, 8: No. 3-4, 75-80(1962). (In Rumanian)

Two minerals having a low U content are analyzed. The quantitative analysis is carried out by the addition method, using for the analytic line the U line at 4241.6 Å. This line is in interference with the Zr line at 4241.6 Å. As an internal standard, the Fe line at 4247.4 Å is used. The U concentrations in the minerals studied are 0.4 and 0.6 ppm. (tr-auth)

**6755** SPECTROPHOTOMETRIC INVESTIGATION OF THE REACTION OF ARSENAZO III WITH $H^+$, $La^{3+}$, $Sm^{3+}$, $Gd^{3+}$, $Dy^{3+}$, AND $Yb^{3+}$. B. Buděšínský (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Řež). Collection Czech. Chem. Commun., 28: 2902-13(Nov. 1963). (In Czech)

The values of the dissociation constants of the proton complexes of Arsenazo III were determined, the compositions of its complexes with $La^{3+}$, $Sm^{3+}$, $Gd^{3+}$, and $Yd^{3+}$ were established, and the values of its formation constants for different pH values as well as the apparent global stability constants were ascertained. The interference influence of other metal ions on the reaction of Arsenazo III with rare earths was established and a method for the simultaneous determination of rare earths and thorium was developed. (tr-auth)

**6756** RADIOSPECTROSCOPIC DETECTION OF SMALL AMOUNTS OF $Eu^{2+}$, $Gd^{3+}$ AND $Nb^{4+}$ AND THEIR ISOMORPHISM IN FLUORITE AND ZIRCON. V. M. Vinokurov, M. M. Zoripov, Yu. E. Polskii, V. G. Stepanov, G. K. Chirkin, and L. Ya. Shekun (Kazan State Univ.). Geokhimiya, No. 11, 1002-6(Nov. 1963). (In Russian)

The results of a study on the electronic paramagnetic resonance spectra obtained from $Eu^{2+}$- and $Gd^{3+}$-ions contained in natural and artificial crystals of $MeF_2$ and from $Nb^{4+}$ in crystals of zircon are presented. The criteria for $Eu^{2+}$ and $Gd^{3+}$ detection in crystals are summarized. The firstly detected electronic paramagnetic resonance spectrum of $Nb^{4+}$ ions in natural zircons is briefly considered. Constants of the spectrum and criteria of the $Nb^{4+}$ detection in crystals are given. (auth)

**6757** EFFECT OF THORON ON EMANATION DETERMINATION OF RADIUM. P. I. Chaykin and T. K. Soprinovskaya. Inform Sb., Vses. Nauchn.-Issled. Geol. Inst., No. 51, 131-3(1961).

It was shown experimentally that during determination of Ra content by the emanation method using 1l ionization chamber the radioactivity of 1 mg of Th at equilibrium corresponds to the radioactivity of $0.21 \cdot 10^{-12}$ g of Ra. Therefore $2 \cdot 10^{-11}$ g of Ra may be determined in the presence of $\leq 6$ mg of Th with $\leq 4\%$ error. An electrometer was used for the measurements. (Referativnyy Zhurnal, Khimiya, No. 15, 1963)

**6758** NEUTRONS MEASURE MOISTURE IN SOLIDS. Robert L. Carver (Nuclear-Chicago Corp., Chicago). Instr. Control Systems, 36: No. 5, 106-7(May 1963).

A gaging system is described in which neutrons are reflected from hydrogenous materials in the sample, thermalized during reflection, and detected. The neutron reflection measurement provides a signal directly proportional to the volumetric moisture percentage. A gamma beam is also directed through the sample, and the gamma reflection measurement provides a signal inversely proportional to density. The two signals are presented to a ratio computer for percent water by weight. (R.E.U.)

**6759** APPLICATION OF OSCILLOGRAPHIC POLAROGRAPHY IN QUANTITATIVE CHEMICAL ANALYSIS. XX. THE OSCILLOGRAPHIC DETERMINATION OF TRACE AMOUNTS OF HEAVY METAL IN HYDROCHLORIC ACID, PURE ALUMINIUM AND ZIRCONIUM. Premysl Beran, Jan Dolezal, and Dusan Mrázek (Charles Univ., Prague). J. Electroanal. Chem., 6: 381-96(Nov. 1963).

A method was developed for the oscillopolarographic determination of trace amounts of copper, lead, cadmium, and zinc in hydrochloric acid. This method was also applied to the simultaneous determination of these metals at concentrations of $10^{-4}-10^{-5}$% in pure aluminum and zirconium. A new method for the quantitative evaluation of the results is proposed. (P.C.H.)

**6760** PHYSICO-CHEMICAL STUDIES OF URANYL ION COMPLEX WITH 2-CARBOXYPYRIDINE N-OXIDE AND GRAVIMETRIC DETERMINATION OF URANIUM. A. N. Kumar and R. P. Singh (Univ. of Delhi). J. Indian Chem. Soc., 40: 774-6(Sept. 1963).

High frequency titrimetric and conductometric studies of uranyl ion complex with 2-carboxypyridine-N-oxide showed that the ratio of uranyl ions and ligands in the molecule, in the pH range 2 to 3, is 1:2. Gravimetric determination of uranium as complex was found possible within the pH range 2 to 3.8. Corrects results were also obtained by ignition of the complex to oxide. The complex is slightly soluble and in case of very dilute solutions, minimum permissible pH is more than 2.0. (auth)

**6761** THE USE OF X-RAY FLUORESCENCE IN DETERMINING STRONTIUM AND CALCIUM. Ernest F. Gloyna (Univ. of Texas, Austin), Surinder K. Bhagat, and William A. Felsing, Jr. J. Water Pollution Control Federation, 35: 893-902(July 1963).

The determination of strontium in the presence of calcium presents a problem with other analytical techniques, but can be handled readily with x-ray fluorescence. The time required for x-ray analysis is relatively short, and microgram amounts can be determined by x-ray fluorescence techniques. Small aliquots of a sample can be used for analysis, and the same samples can be replaced for further processing because x-ray analysis does not modify or destroy the sample. (TCO)

**6762** A METHOD FOR THE DETERMINATION OF CHLORIDE TRACE AMOUNTS AND THE STEP COOLING WATER. Teresa Zielinska (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 206-8(1963). (In Polish)

From a number of known methods of determining chlorine content in water, an indirect colorimetric method was elected in which diphenylocarbozene and mercuric nitrate are utilized. This method is based on the phenomenon of bonding chlorine ions with a predetermined amount of added mercury ions, and on the presence of very weakly dissociated mercuric chloride. The $Hg^{2+}$ ion content is determined colorimetrically by making use of the mercury reaction with diphenylocarbozene. The accuracy of the chlorine determination in cooling water of the reactor's primary cooling loop varies from 8% to a minimum of 0.5%. This degree of accuracy can be obtained only with greatest cleanliness in preparing the colored solution and during the evaporation of the water sample. (TTT)

**6763** EQUIPMENT FOR MEASURING THE DEGREE OF CONTAMINATION OF WATER WITH BETA-GAMMA ACTIVE SUBSTANCES. V. A. Chizhov, Yu. A. Yuzvuk, A. A. Pozdnyakov, E. K. Sakseev, A. V. Kalistratova, V. K. Sysoev, and A. V. Yakov. Sb. Rabot po Nekotorym Vopr. Dozimetrii i Radiometrii Ioniziruyushchikh Izluchenii, 2: 187-91(1961).

Equipment is described for determining $Sr^{90} + Y^{90}$ in drinking water and in sewage water at concentration (in curie/liter respectively): $5 \times 10^{-9}$–$5 \times 10^{-8}$; $5 \times 10^{-9}$–$5 \times 10^{-6}$; $5 \times 10^{-11}$–$5 \times 10^{-8}$. (OTS)

**6764** EMPIRICAL FORMULA FOR SELF-SHIELDING EFFECT IN NEUTRON ACTIVATION. Minoru Okada. Tokyo Kogyo Shikensho Hokoku, 58: 469(Oct. 1963). (In Japanese)

Previously a formula was presented for the case when an irradiated sample of nearly spherical shape was dissolved before activity measurement and when the self-shielding effect was 10 per cent (NSA 16: 16415). Additional data were collected from a paper that appeared in Nippon Kagaku Zasshi 83: 1164 (1962), and a revised curve, which is more accurate, was obtained, from which a new formula was developed. (C.E.S.)

**6765** INDUSTRIAL ACTIVATION ANALYSIS UNIT WITH 14-Mev NEUTRON GENERATOR AND ITS APPLICATIONS. HIGHLY ACCURATE NEW MONITORING SYSTEM SHORTENS TO ONE MINUTE THE TIME OF DETERMINING AMOUNT OF OXYGEN IN MATERIALS. Isao Fujii, Katsuhiko Miyoshi, Haruo Muto, and Yutaka Maeda (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rev., Intern. Ed., No. 15, 32-9(1963).

An inexpensive, rapid, nondestructive activation analysis unit for industrial purposes, which utilizes a 14-Mev neutron generator, is described and its applications cited. The device is completely automated, with all the processes of analysis being controlled by two operations, Reset and Start, alone. The device is named C-R neutron monitoring system (or automatic normalizing unit). By means of this device, the oxygen contents in coal, pure materials, and metals have been determined, the required time being about one minute. The maximum practical sensitivity of the method is 10 ppm at a neutron output of $10^{10}$ neutron/sec, and the precision at this level is ±15%. (P.C.H.)

**6766** A METHOD FOR DETERMINATION OF RADIOELEMENTS IN OCEAN DEPOSITS. I. E. Starik and Yu. V. Kuznetsov. Tr. Inst. Okeanol. Akad. Nauk SSSR, 55: 121-30(1962).

Two variations of a method are described for the determination of Ionium [$Th^{230}$] in ocean deposits. In the first variation after addition of $UX_1$ indicator to the sample of sediment and dissolution the separation of Th isotopes from the accompanying elements is realized by means of triple precipitation with $CaC_2O_4$. Oxalates are converted to carbonates in the muffle furnace, which are later treated with 5% solution of HCl. The obtained solution is made alkaline with an equal volume of concentrated $NH_3$, which is $CO_2$ free, filtered through blue ribbon filter paper. The filter paper adsorbs Th under these conditions. Desorption is conducted by hot 5% solution of HCl. After the third reprecipitation desorption is done with 1N $HNO_3$. To separate Th from Po this solution is electrolyzed in pt cup and after concentration $\alpha$-activity of Th isotopes is measured and the Th yield is determined from the $UX_1$ indicator. In the second variation separation of Th isotopes from the main mass of accompanying elements is done by means of passing 30% HCl solution through cationite KU-2 with subsequent elution with 10% hot solution of $H_2O_2O_4$. Final purification is done by a single coprecipitation with $CaC_2O_4$. Further operations are the same as above. The completeness of isolation of Th isotopes in both variations is 85–90%. To calculate the activity due to ionium from the measurement of total $\alpha$-activity, the activity due to $Th^{232}$ and $Th^{228}$ is subtracted. By means of thoron reagent, Th content is determined, equilibrium concentration of $Th^{228}$ is calculated, and also $\alpha$-activity that results from these isotopes. The $Th^{227}$ content may be neglected. Particular attention must be paid to the radiochemical purity of $UX_1$ indicator and reagents. The determination of Ra in sea deposits is conducted by a radioemanation method and that of U by luminescence. (Referativnyy Zhurnal, Khimiya, No. 15, 1963)

**6767** POSSIBILITY OF QUANTITATIVE DETERMINATION OF $Sr^{90}$ ON GLASS POWDER. R. Kipiani, K. Gvozdev, and A. Krupennikova. Tr. Inst. Zøshchity Rast., Gruz. SSR, 14: 275-6(1961).

The separation of $Sr^{90}$–$Y^{90}$ by the sorption method of glass has been investigated and the method is proposed for the determination of $Sr^{90}$. From the analyzed sample elements of the second group were isolated by the oxalate method and converted to chlorides. Dry precipitate was kept for 12 days to achieve $Sr^{90}$–$Y^{90}$ equilibrium, dissolved in alkali and passed through column field with a layer of glass powder (2 cm), which was previously washed with acid and alkaline solution of $Sr(OH)_2$. After washing the column with alkaline solution of pH 8–9, Sr passed into filtrate, and $Y^{90}$ was then eluted from the glass powder with 1% solution of $HNO_3$ containing stable Y. The identification of $Y^{90}$ and $Sr^{90}$ was conducted from half absorption of radiation and radioactive decay. Various types of glass were investigated as adsorbents: pyrex, Jena, window, and quartz glass. The most reliable results were obtained with quartz glass. (Referativnyy Zhurnal, Khimiya, No. 13, 1963)

**6768** AMPEROMETRIC TITRATION OF ZIRCONYL CHLORIDE WITH POTASSIUM FERROCYANIDE. J. N. Gaur (Univ. of Rajasthan, Jaipur, India). Z. Anal. Chem., 194: 47-9(1963).

Amperometric titrations of zirconyl chloride with potassium ferrocyanide were carried out by the dropping mercury electrode at a potential of −1.8 v. The reaction of the two compounds takes place in the ratio of 2 : 1 with the formation of $(ZrO)_2Fe(CN)_6$. This affords a sensitive method for the estimation of zirconium in zirconyl solutions. (auth)

**6769** QUANTITATIVE X-RAY SPECTRAL ANALYTICAL DETERMINATION OF POTASSIUM, RUBIDIUM, STRONTIUM, BARIUM, TITANIUM, ZIRCONIUM, AND PHOSPHORUS. STATISTICAL INVESTIGATION OF THE DISTRIBUTION OF THESE ELEMENTS IN MINERAL PHASES. Paula Hahn-Weinheimer and Helmuth Ackermann (Universität, Frankfurt am Main). Z. Anal. Chem., 194: 81-101(1963). (In German)

The local heterogeneity of K, Rb, Ti, Zr, P, Sr, and Ba was determined by x-ray fluorescence analysis as a first step in investigations of the regional heterogeneity of a whole granite body of larger extent. The first granite of this series is the Malsburg-Granite in the southwest of the Black Forest. The analytical results are reproducible and accurate, if the rock samples are ground below 450 mesh. The errors and mean deviations caused by counting, instrumentation, and preparation are small in comparison with those in a rock sample of an outcrop or the whole rock body. The method of x-ray fluorescence analysis can be applied for the study of the mechanism of magmatic intrusion and differentiation. (auth)

**6770** SPECTROPHOTOMETRIC STUDY ON THE THORIUM COMPLEX OF β-SNADNS-6. Sachindra Kumar Datta and Sachindra Nath Saha (Victoria Coll., Cooch Behar, India). Z. Anal. Chem., 194: 340-6(1963).

The dye β-SNADNS-6, was prepared from chromotropic acid and 2-naphthylamine-6-sulfonic acid. The blue thorium complex of this dye was studied spectrophotometrically. The complex forms in the pH range 2 to 4, the

maximum color development occurs at a very narrow pH range of 2.5 to 3. The maximum absorption of the complex occurs at 590 nm. The color reaction is fairly sensitive. The molar absorption coefficient of the complex is 20,604. The average formation constant of the thorium chelate, determined by various methods, was calculated as $1.25 \times 10^5$. Only one complex having the composition 1 : 1 is formed. (auth)

**6771** DETERMINATION OF SMALL AMOUNTS OF PARAMAGNETIC AND DIAMAGNETIC IONS BY THE METHOD OF NUCLEAR MAGNETIC RELAXATION. A. A. Popel and E. D. Grazhdannikov (Kazan State Univ.). Zh. Analit. Khim., 18: 1291-4(Nov. 1963). (In Russian)

The sensitivity of the method of proton magnetic resonance to paramagnetic ions can be increased one-two orders by considerably diminishing the time of transverse proton relaxation in certain chemical systems. The times of transverse proton relaxation were measured in diluted solutions of $Mn^{2+}$, $VO^{2+}$, and $Cu^{2+}$ ions in water, in 10 N $H_2SO_4$ and in a 5.6 M aqueous solution of ethanolamine, correspondingly, and a minimum determinable concentration of these ions was estimated. The sensitivity of the magnetic relaxation method on fluorine nuclei to copper ions ($6.10^{-10}$ M) was determined. Taking as an example the mixtures of thorium and magnesium ions the possibility is shown of determining diamagnetic ions by the nuclear magnetic relaxation method using a paramagnetic ion as an indicator of the end of titration. (auth)

**6772** PHOTOMETRIC DETERMINATION OF RARE EARTHS IN ORES WITH ARSENAZO III. V. G. Goryushina, S. B. Savvin, and E. V. Romanova (State Scientific-Research and Design Inst. of Rare Metal Industry and Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). Zh. Analit. Khim., 18: 1340-4(Nov. 1963). (In Russian)

The photometric method with the use of arsenazo III is the most sensitive and selective for the determination of rare earths. Down to μg of rare earths in 50 ml at pH 1.8 can be determined by adding 2 ml of a 0.1% arsenazo III solution in the presence of 5 mg of aluminium masked with sulfosalicylic acid and of 0.5 mg of zirconium masked with oxalic acid. Iron reduced with hydroxylamine hydrochloride in amounts of 5 mg does not interfere. Many other elements including magnesium, barium, copper, nickel, manganese, chromium, tin, and titanium do not interfere in amounts by two and more orders higher than those of rare earths. The effect of calcium is eliminated by adding its equal amounts into the blank. The method can be used for determining the total rare earths in ores of various deposits. The separation from accompanying elements can be effected by a simple procedure—precipitation of oxalates or hydrates. The necessary sample weight is 0.1 g. The sensitivity of the method is 0.01%. (auth)

**6773** DETERMINATION OF MANGANESE IN SILICON BY A RADIOACTIVATION METHOD. E. M. Lobanov, V. I. Zvyagin, A. A. Kist, B. P. Zverev, A. I. Sviridova, and G. A. Moskovtseva (Inst. of Nuclear Physics, Tashkent). Zh. Analit. Khim., 18: 1349-55(Nov. 1963). (In Russian)

It is shown that manganese can be determined in silicon with a satisfactory accuracy by means of γ spectrum of the sample activated with neutrons. γ Spectrum of the silicon (1.26 Mev) can be used as a standard, which makes the analysis more rapid and simple. When interfering impurities are present after the radiochemical separation it is better to use a γ-spectrographic method of analysis as it is more rapid in comparison with the β-activity measurements. More reliable data on manganese concentration in silicon were obtained by using a combination of four modifications of the activation analysis. (auth)

**6774** USE OF THE METHOD OF NEUTRON ABSORPTIOMETRY FOR THE DETERMINATION OF BORON CONTENT IN BORONORGANIC COMPOUNDS. N. G. Malysheva, L. P. Starchik, I. S. Panidi, and Ya. M. Paushkin (Gubkin Inst. of Petroleum Chemical and Gas Industry, Moscow). Zh. Analit. Khim., 18: 1367-9(Nov. 1963). (In Russian)

A method is suggested for determining B in organic compounds by neutron absorptiometry. (auth)

**6775** ISOTOPIC ANALYSIS AT THE C.E.G.B.'S CENTRAL RADIOCHEMICAL LABORATORY. M. J. Owers (Central Electric Generating Board, London). 31p. (CONF-365-21)

From Symposium on Environmental Monitoring, Berkeley, Gloucestershire, England, Oct. 1963.

Samples of milk, herbage, plant-base, and soil, collected in the neighborhood of nuclear power stations, were analysed for $Sr^{90}$, $Sr^{89}$, $Cs^{137}$, and also for natural strontium and calcium. No radioactive contamination was found in the environments of Bradwell, Berkeley, Hinkley Point, or Trawsfynydd nuclear power stations that can be attributed to the Board's operations. Where valid comparisons are possible, good agreement was found with results previously determined by others. The long-lived isotopic contamination of the samples examined agrees well in general with that expected to occur from the debris of known nuclear test explosions. (P.C.H.)

**6776** ACTIVATION ANALYSIS WITH THE MICHIGAN REACTOR: APPLICATION TO MICHIGAN PROBLEMS. Harold W. Nass (Univ. of Michigan, Ann Arbor). 8p. (CONF-138-1).

From 11th Detroit ANACHEM Conference, Detroit, Oct. 1963.

A review is presented on activation analyses performed by the Michigan reactor. Typical determinations include: sodium deposited on gold leaf for nuclear physics experiments; cobalt and silver in high purity copper used in electron diffraction studies; sodium, manganese and chlorine in experimental reactor grade terphenyl; zirconium in an experimental tungsten–chromium alloy; argon, vanadium, manganese, chlorine, scandium, and iron in spectroscopic grade carbon rod; vanadium and aluminum in synthetically grown sapphires used for x-ray fluorescence studies; hafnium in uranyl nitrate; aluminum in silicon catalyst; vanadium in synthetic cadmium–telluride crystals used in electron spin resonance studies; and sodium and potassium in human tissue from internal organs. Analyses on oil samples and cadmium rod have also been performed. (P.C.H.)

**6777** URANIUM DIOXIDE IN STAINLESS STEEL. DETERMINATION IN SOLUTION BY X-RAY FLUORESCENCE SPECTROMETRY. Louis Silverman. p.1107-8 of "Encyclopedia of X-rays and Gamma Rays." New York, Reinhold Corp., 1963.

X-ray fluorescence spectrometry and radiolysis of stainless steel-$UO_2$ compact dissolved in aqua regia, perchloric acid, and hydrofluoric acid was used to determine the $UO_2$ content. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**6778** A METHOD OF AND APPARATUS FOR DETERMINING ELEMENTS IN LIQUID AND GASEOUS SUBSTANCES BY X-RAY ABSORPTION ANALYSIS. (to Chemische Werke Huls AG). British Patent 945,730. Jan. 8, 1964. Priority date July 31, 1961, Germany.

An analysis method for elements in liquids or gas was developed. The substance to be analyzed is irradiated

with the characteristic x-ray spectra of an element excited by $\beta$ or $\alpha$ particles that has an atomic number exceeding the atomic number of the element which is to be determined by at least 2. The specific absorption of this characteristic radiation in the region of the K or L absorption edge of the element that is to be determined is measured. (M.C.G.)

**6779** APPARATUS FOR THE ANALYSIS OF GAS MIXTURES BY ABSORPTION OF RADIATION. Werner Schaefer and Wolfgang Siebert (to Hartmann and Braun AG). U. S. Patent 3,116,413. Dec. 31, 1963. Priority date July 4, 1959, Germany.

An instrument for analyzing gases by absorption of infrared radiation is designed which is independent of gas pressure. The instrument comprises two chambers, one for a reference gas and the other for the gas being analyzed, radiation sources, detector means for comparing the amount of radiation absorbed by the gases in the chambers, and means for varying the strength of the beam passing through the sample chamber in accordance with the gas pressure. (D.L.C.)

## Inorganic and Physical Chemistry

*Refer also to abstract 7774.*

**6780** (AD-299997) CROSS RELAXATION IN NON-ZEEMAN SPIN SYSTEMS. Technical Report No. AF-101. Jan M. Minkowski (Johns Hopkins Univ., Baltimore. Carlyle Barton Lab.). Feb. 1963. Contract AF33(616)-6753. 179p.

The theory of cross relaxation in diluted spin systems was investigated. To subject the theory to a quantitative comparison with the results of the experimental study of a non-Zeeman spin system, previous techniques of computing the moments of the line shapes were modified. This new method gives the 2n-th moment of cross-relaxation lines as a polynomial of the n-th order in the concentration f of the paramagnetic ions. The order of the polynomial in f is shown to be independent of the order of the cross-relaxation process. The leading term in all of the moments is concentration independent and it can be determined with much less labor by the technique developed below than by any of the earlier methods. The new technique is applied to show that the moments of the line shape of paramagnetic lines are also polynomials in f, but the concentration independent terms are missing. The reasons underlying this difference in f-dependence of the paramagnetic and cross-relaxation line shapes are discussed. It is shown that it is necessary to use (m-1)th order of perturbation theory to account for the cross-relaxation processing involving m spins. On the basis of this result, by using only the leading terms of the moments, the cross-relaxation rates associated with two types of three-spin processes are computed for the spin system of $Cr^{3+}$ ions diluted in potassium cobalt-hexacyanide. Experimental determination of the cross-relaxation rates is achieved by performing steady-state and pulse-saturation experiments and combining their results. The pulse-saturated spin system is made to recover to a stationary state, different from Boltzmann equilibrium, by maintaining continuous saturation of certain transitions. In this way the recovery takes place with a single time constant. Experiments were performed in the concentration range from 0.03 to 1.00%. Calculated intensities and line shapes agree well with the experimental results in the region of concentrations in which the line shapes are independent of concentration. For intermediate concentrations, f > 0.5 per cent, experimental line shapes deviate from those computed. This is expected since only the f-independent terms of the theoretical moments were determined. (auth)

**6781** (AERE-R-4370) THE PREPARATION OF HIGH-PURITY BERYLLIUM OXIDE. K. R. J. Cottell (United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Chatham Outstation, Kent, England). Oct. 1963. 11p.

Some procedures for the preparation of high-purity beryllium oxide were examined. By combining the most efficient purification stages, a method was devised which gives a product having less than 1 ppm of most metallic impurities. (auth)

**6782** (BNL-7423) CURRENT STUDIES OF FISSION PRODUCT BEHAVIOR AT BNL. A. W. Castleman, Jr. and F. J. Salzano (Brookhaven National Lab., Upton, N. Y.). Sept. 1963. Contract AT-30-2-GEN-16. 21p. (CONF-255-10)

From 8th Air Cleaning Seminar, Oak Ridge, Tenn., Oct. 1963.

Studies were made of the iodine release from irradiated metallic U and U–3.5% Mo alloy melted at ~1200°C, into inert (He), oxidizing (air), and reducing (steam) environments. The results indicate that the released species in He is uranium iodide, probably $UI_3$, while that in air is elemental iodine. More than 90% of the iodine released from U in steam is in the form of iodide ions. The adsorption of iodine on TSX (high-purity) graphite at 800 to 1000°C was also studied. The results showed no relation between surface area and amount sorbed at 200 to 800°C, indicating chemisorption. However, physical adsorption probably occurs at 100°C. An equation is proposed for estimating iodine adsorption in a graphite reactor core at temperatures > 553°C and pressures < $10^{-3}$ mm Hg: $Q(ppm) = 3.2 \times 10^{-4} P^{½} T^{-¼} \exp(20{,}000/RT)$, where P = partial pressure of iodine in mm Hg and T = absolute temperature. (D.L.C.)

**6783** (BNL-7431) A MODEL FOR CURRENT REVERSAL CHRONOPOTENTIOMETRY WITH KINETIC COMPLICATIONS. S. W. Feldberg and Clemens Auerbach (Brookhaven National Lab., Upton, N. Y.). Oct. 2, 1963. Contract AT-30-2-GEN-16. 21p. (CONF-117-35)

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

A model was developed for the analysis of current-reversal chronopotentiograms in systems where the electrode process is followed by a homogeneous second-order reaction. The model is analyzed using the IBM 7094 digital computer programed in FORTRAN language. Working curves, derived with the aid of dimensional analysis, can be used to evaluate rate constants from experimental data. The electroreduction of uranium(VI) to uranium(V) with subsequent second-order disproportionation of uranium(V) was studied as an experimental test of the model. Disproportionation rate constants thus obtained are in satisfactory agreement with previously reported values. Other possible applications of the model are discussed. (auth)

**6784** (BNL-7518) CORRELATION OF KINETIC ISOTOPE EFFECTS WITH CHEMICAL BONDING IN THREE CENTER REACTIONS. Jacob Bigeleisen (Brookhaven National Lab., Upton, N. Y. and Zürich. Eidgenössische Technische Hochschule). [Oct. 28, 1963]. 15p. (CONF-269-2; SM-50/24)

From International Atomic Energy Agency Symposium on

Isotope Mass Effects in Chemistry and Biology, Vienna, Dec. 1963.

The kinetic isotope effect in three center reactions of the type A + BC → AB + C is considered. Such model calculations are a good approximation to primary hydrogen isotope effects. For abstraction or transfer reactions, B becomes H, D, or T. The dynamics of the three atom system are calculated for a general quadratic potential, with the assumption that the potential energy is constant along the reaction coordinate (flat top barrier). This model system can be calculated in detail and serves to illustrate the relationship between kinetic isotope effect and chemical bonding in the transition state. The statistical mechanical part of the calculation can be carried out exactly within the framework of transition state theory or in any one of a number of approximations. The $\bar{\gamma}$ method gives particularly good insight into the chemistry of the problem with a minimum of arithmetic. One finds that "symmetrical" transition states have the maximum normal kinetic isotope effects. Transition states which lie close to reactant or product lead to small kinetic isotope effects. This holds not only for the factor associated with the zero point energy, but also for the frequency factor, which arises from the rate of crossing the barrier. It is shown that when the kinetic isotope effect is of the Arrhenius type, the "temperature independent factor or frequency factor" for a system of linear molecules and transition states is given by the square root of the ratios of molecular weights. This is identically the same result as that of the collision theory. In both cases the factor arises from the density of states in momentum space (along the line of collision). (auth)

**6785** (CONF-117-33) PREPARATION OF DENSE URANIUM DIOXIDE PARTICLES FROM URANIUM HEXAFLUORIDE IN A FLUIDIZED BED. Irving E. Knudsen, Norman Levitz, and Albert A. Jonke (Argonne National Lab., Ill.). Sept. 1, 1963. Contract W-31-109-eng-38. 22p.

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

A fluid-bed method was developed for the direct preparation from uranium hexafluoride of dense, spheroidal uranium dioxide particles for dispersion and packed fuel element applications. The uranium hexafluoride is reacted with mixtures of steam and hydrogen in a bed of uranium dioxide maintained at 650 to 700°C, the solid reaction products depositing as a dense layer on the surface of the bed particles. The operating procedure involves alternating periods of uranium hexafluoride feed with periods of fluoride cleanup when only steam and hydrogen are fed. Uranium dioxide particles in the size range − 16 + 140 mesh and having densities of 9.5 g/cc and 9.75 g/cc (up to 89% of theoretical density) were produced at 650°C and 700°C, respectively, using a uranium hexafluoride feed rate of 25 g/min [44 lb uranium/(hr)(sq ft reactor cross section)]. The average residual fluoride content of the uranium dioxide was about 300 ppm. The densest material was obtained when 0.75 to 1.4 times the stoichiometric steam requirement (based on the reaction $UF_6 + 2H_2O + H_2 \rightarrow UO_2 + 6HF$) was used. The effect on product density of other process variables such as uranium hexafluoride feed rate, hydrogen concentration, bed height, and duration of hexafluoride feed period was also determined. Further densification of the material to 10.4 to 10.6 g/cc, up to 96.5% of theoretical density, and reduction of the fluoride content to about 5 ppm was achieved by sintering in hydrogen at about 1700°C for 2.5 hours. (auth)

**6786** (CONF-135-3) CHEMICAL BONDING FROM HIGH-TEMPERATURE STUDIES; SUBLIMATION OF REFRACTORY COMPOUNDS. R. J. Ackermann and R. J. Thorn (Argonne National Lab., Ill.). [1963]. Contract [W-31-109-eng-38]. 47p.

From International Symposium on High Temperature Technology, Asilomar, Calif., Sept. 1963.

A thermodynamical definition is given of high-temperature chemistry, and a review is presented of studies of sublimation of refractories with respect to bonding at high temperatures. The molecular orbital theory and dissociation energies of monoxides are used to study bonding in diatomic molecules. Nearest-neighbor theories are also used to study bonding in solids and the energies associated with lattice defects. The sublimation behavior of refractory oxides is rationalized according to the metal position in the periodic table. The factors causing a minimum in pressure-composition curves near a stoichiometric compound and near the pure metal are examined. (D.L.C.)

**6787** (CONF-202-4) AN ELECTROCHEMICAL pH-STAT. F. A. Posey, T. Morozumi, and E. J. Kelly (Oak Ridge National Lab., Tenn.). [1962]. Contract [W-7405-eng-26]. 29p.

From the Electrochemical Society Fall Meeting, New York, Sept. 1963.

An apparatus was developed which controls automatically the acidity of unbuffered solutions in the region from pH = 4 to pH = 10. A potentiostat is used to control the potential of an inert electrode on which the hydrogen gas-hydrogen ion reaction occurs in a solution saturated with hydrogen gas. The inert electrode acts as both a sensing element and a regulating electrode for the control of acidity. Current from the potentiostat passes through the inert electrode and an auxiliary polarizing electrode in an external compartment separated from the main cell by a salt bridge or porous plate. Transients which occur during the regulating action are presented and analyzed. The electrochemical pH-stat may be used to measure corrosion rates. Limitations of the device are discussed and a modification is proposed which makes use of a differential amplifier instead of a potentiostat. (auth)

**6788** (IA-875) STRONG HYDROGEN BONDS AND THE STRUCTURE OF LIQUID WATER. I. Pelah and J. Imry (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). Oct. 1963. 10p.

A model is proposed to explain the anomalous properties of liquid water. The model pictures water as built of relatively large strongly hydrogen bonded clusters (containing several hundred molecules), in equilibrium with $H_2O$ gas. This picture and the new theory of strong hydrogen bonds account for many anomalies, such as the negative thermal expansion, the increase in volume upon freezing, the high specific heat, details of P−V−T curves under high pressures, results of neutron scattering, etc. Further work is needed to make the model more quantitative and to amass more experimental evidence for the existence of short hydrogen bonds in water. (auth)

**6789** (IDO-11007) VISCOSITY AND THERMAL CONDUCTIVITY OF POLYPHENYLS IN THE LIQUID AND VAPOR STATES. Final Report. W. H. Hedley, M. V. Milnes, and W. H. Yanko (Monsanto Research Corp. Dayton Labs., Ohio). July 31, 1963. Contract AT(10-1)-1088. 80p.

Viscosity and thermal conductivity data for liquid and vapor biphenyl and ortho-, meta-, and para-terphenyl (all 99.5+ per cent pure) were determined for use in heat transfer correlations. The liquid properties were measured over a temperature range at atmospheric pressure and equations were fitted to the data. Liquid viscosities were measured

using capillary viscometers, and thermal conductivities were determined with a hot wire apparatus. Viscosities and thermal conductivities for vapor states were calculated at low pressure and at saturation. Equations for low-pressure vapor viscosity were developed by the Bromley-Wilke method, and for low-pressure vapor thermal conductivity by the method of Bromley. For the saturated vapors, viscosity equations were established using the method of Grunberg and Nissan, and thermal conductivity equations were established based on corresponding pressure states relationship. Using these equations, liquid and vapor viscosity and thermal conductivity values were calculated up to at least 850°F in 10°F increments via IBM-704 computer. The thermal conductivities of unsaturated polyphenyl vapors were calculated by the method of Lenoir, Junk and Comings at reduced temperatures above one and at reduced pressures of 0.2 to 2. Heat transfer capabilities of liquid and vapor biphenyl and the terphenyls were evaluated by use of their determined physical properties and the Dittus-Boelter equation. For heat transfer, liquid biphenyl is superior to the terphenyls below 700°F whereas ortho-terphenyl excels above 700°F. Liquid mixtures of biphenyl with ortho- or meta-terphenyl are better for heat transfer than any of the pure materials above 550°F. (auth)

**6790** (NP-13453) GENERATION AND DECAY OF SMALL IONS. Final Report. (Minnesota. Univ., Minneapolis). Sept. 1963. 130p.

The results of experimental and theoretical studies on the decay of small unipolar ions, aerosol decay, and diffusion charging of aerosol in non-flow and steady flow systems are presented. The aerosols analyzed in each system were natural atmospheric contamination and generated aerosols. The generated aerosols were solid, spherical, fluorescent, nondispersed, initially electrically neutral, and homogeneous. These aerosols were generated and tested in sizes varying from a mass median diameter of 0.028 to 3.6 microns having a standard deviation of 1.1 to 1.67. (auth)

**6791** (SRIA-105) DENSITIES OF LIQUID SOLUTIONS OF BISMUTH AND SULFUR. Technical Report No. XVIII. Daniel Cubicciotti (Stanford Research Inst., Menlo Park, Calif.). Aug. 7, 1963. Contract AT(04-3)-106. 13p.

Densities of liquid solutions of bismuth and sulfur were measured over the composition range from pure bismuth to 0.65 atom fraction sulfur and at temperatures from just above the liquid-solid equilibrium to 700 to 800°C. The molar volume of the melts was found to be a linear function of the atom fraction of sulfur; the partial molar volume of bismuth is 20.9 ml/g atom (equal to its molar volume) and that of sulfur (by extrapolation) 13 ml/g atom at 300°C. A speculation on the nature of the solutions is made. (auth)

**6792** (TID-19898) PROPERTIES OF MATERIALS AT HIGH TEMPERATURES. Technical Progress Report, October 15, 1962 to October 14, 1963. John L. Margrave (Wisconsin. Univ., Madison). Oct. 15, 1963. Contract AT(11-1)-835. 97p.

Progress is reported of research on the high-temperature properties of selected materials. The results of studies of the oxidation of TiO and of the electrical resistivity and optical absorption properties of several Ti oxides are summarized. The heat of formation of $S_4N_4$ is reported. Included in appendices are work on pyrolytic graphite and a literature survey on nitrides and azides; separate abstracts were prepared for them. (D.L.C.)

*For abstracts of individual papers see: 6793 and 6794.*

**6793** (TID-19898(App.I)) THE HEATS OF COMBUSTION OF SOME PYROLYTIC GRAPHITES AND THE STANDARD REFERENCE STATE FOR CARBON. David C. Lewis, Margaret A. Frisch, and John L. Margrave (Wisconsin. Univ., Madison). 5p.

The standard heats of formation of $CO_2$(g) were measured for spectroscopically pure graphite (SP-2) and for four pyrolytic graphite samples which were annealed at 2200 to 3600°C. The SP-2 graphite had a heat of − 94.042 kcal/mole, in excellent agreement with literature, while the heats of the pyrolytic graphites ranged from − 93.974 to − 94.226 kcal/mole. The reasons for the discrepancies are discussed, and the choice of the pyrolytic graphite annealed at 3000 to 3600°C as the standard state of carbon is considered. (D.L.C.)

**6794** (TID-19898(App.II)) BINARY NITROGEN COMPOUNDS OF THE ELEMENTS. A Literature Survey. Rosemary G. Ehl, James P. Piper, Phyllis R. Clopper, and John L. Margrave (Rice Univ., Houston, Tex. and Wisconsin. Univ., Madison). 85p.

A detailed literature survey is presented of inorganic nitrides and azides from June 1959 to July 1963. The literature survey includes a bibliography of 1225 references and a set of tables for locating the data for the properties of nitrogen compounds. Periodic tables of all the nitrides and azides are also included. (D.L.C.)

**6795** (TID-19901) THE COPRECIPITATION OF $Sr^{+2}$ WITH CALCITE AND ARAGONITE AT 150°C. Technical Report No. 6. H. D. Holland (Princeton Univ., N. J.). [nd]. Contract AT(30-1)-2266. 41p.

The strontium content of calcite and of aragonite precipitated from aqueous solutions at 150° by means of the hydrolysis of formate ions was studied, and the distribution coefficients $k^{C}_{Sr}$ and $k^{A}_{Sr}$ were measured. The values of $k^{C}_{Sr}$ fall between 0.073 and 0.121, those of $k^{A}_{Sr}$ between 0.61 and 0.92. The observed range of values is due in part to a time effect and in part to the effect of the composition of the solutions. Both $k^{C}_{Sr}$ and $k^{A}_{Sr}$ tend to decrease with time of contact of the precipitated $CaCO_3$ with the aqueous phase at 150°C. In all of the experiments, the value of the distribution coefficient reflects conditions at the surface of calcite and aragonite crystals during their growth since body diffusion was much slower than the rate of crystal growth in the experiments. The applicability of the data to geologic situations depends on the response of the value of the distribution coefficient $k^{C}_{Sr}$ and $k^{A}_{Sr}$ to the almost certainly slower rate of growth characteristic of most hydrothermal calcites. (auth)

**6796** (UCRL-10757) SOME PROPERTIES OF SOLID HYDROGEN AT SMALL MOLAR VOLUMES (thesis). Guenter Ahlers (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley). Sept. 24, 1963. Contract W-7405-eng-48. 137p.

Apparatus and experimental procedures are described for the measurements of properties of solid hydrogen over the volume range from 15 to 23 cc/mole and the temperature range from 1.3 to 20°K. The lattice heat capacity of hydrogen was measured at constant pressure, and at 22.56, 19.83, and 18.73 cc/mole. The results are compared with simple theories, and with the lattice properties of other solids. Some thermodynamic properties of solid hydrogen are deduced from the heat-capacity measurements. The effect of volume changes on the λ anomaly in ortho hydrogen was measured over the volume range from 15.8 to 22.6 cc/mole. The results are in agreement with qualitative predictions based on the intermolecular potential, but the de-

tailed nature of the anomaly is found to be rather complicated. The kinetics of the ortho-para conversion in solid hydrogen was studied over the volume range from 16 to 22.6 cc/mole and the temperature range from 1.6 to 20°K. (auth)

**6797** (UCRL-11081) A STUDY OF THE REACTIONS BETWEEN GASEOUS AMMONIA AND SULFUR CHLORIDES (thesis). Milagros Villena-Blanco (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 21, 1963. Contract W-7405-eng-48. 36p.

The reaction between gaseous ammonia and sulfur chlorides ($S_2Cl_2$ and $SCl_2$) was studied under various conditions of temperature, flowrate of ammonia, concentration and type of sulfur chloride, solvent, and duration of run, for the purpose of determining the optimum conditions for the preparation of $S_4N_4$ and $S_7NH$. Adsorption-column chromatography on alumina and silica gel columns was employed for the quantitative separation of the reaction products. (auth)

**6798** (AEC-tr-6232) COMPLEX FORMATION BETWEEN ALKALI METAL FLUORIDES AND FLUORIDES OF THE LANTHANUM GROUP METALS. E. P. Dergunov. Translated for Oak Ridge National Lab., Tenn., from Dokl. Akad. Nauk SSSR, 85: 1025-8(1952). 6p.

The systems of the alkali metal fluorides with fluorides of Er, Sm, and Pr were investigated using the visual polythermal method. Particular attention was paid to the effects of the radii of the cations located in the outer and inner coordination spheres on the complex formation and stability. The results indicated a tendency to form cryolite-type complex compounds of composition $Me_3ErF_6$, $Me_3SmF_6$, and $Me_3PrF_6$, where Me alkali metal, and the tendency decreases with the ionic radius of the lanthanide and increases with the ionic radius of the alkali metal. (D.L.C.)

**6799** (AEC-tr-6244) VOLTA POTENTIAL DIFFERENCES BETWEEN ELECTROLYTE SOLUTIONS AND ACTIVITY COEFFICIENTS OF SEPARATE IONS. N. A. Izmailov and Iu F. Rybkin. Translated by Helen J. Chick and Marvin M. Mueller (Los Alamos Scientific Lab., N. Mex., from Dopovidi Akad. Nauk Ukr. RSR, No. 1, 69-73(1962). 8p.

The relation between the real and chemical energies of solvation of ions depends on the surface potential of the solution. Contact potential differences between solutions of different HCl and NaCl concentrations in water with and without 1% additions of n-amyl alcohol were measured in order to study the dependence between the changes of the chemical and real energies of solvation of separate ions. The results were used to calculate real activity coefficients of $H^+$ and $Cl^-$ ions, which are plotted vs square root of concentration. It is shown that the surface potential of NaCl solutions without n-amyl alcohol hardly changes with concentration. The change of surface potential of HCl solutions with concentration is calculated and plotted. (D.L.C.)

**6800** EQUILIBRIUM DISTRIBUTION OF METAL-FLUORIDE COMPLEXES. Gerald Goldstein (Oak Ridge National Lab., Tenn.). Anal. Chem., 36: 243-4(Jan. 1964).

Equilibrium data for the formation of metal complexes with inorganic ligands are compiled in the form of distribution diagrams (fraction of each species present vs ligand concentration), with the necessary calculations and plotting performed by means of a high-speed computer. Diagrams of Be, VO, $UO_2$, Al, Ga, In, Sc, Y, Cr, Fe, TiO, Zr, Hf, and Th fluoride complexes are illustrated. (P.C.H.)

**6801** THE EFFECT OF TRI-, TETRA-, PENTA-, AND HEXAPHOSPHATE ON THE CRYSTALLIZATION OF STRONTIUM SULFATE. Masajai Miura, Sadaichi Otani, Yasuhiro Abe, and Chikako Fukumura (Hiroshima Univ.). Bull. Chem. Soc. Japan, 36: 1091-3(Sept. 1963).

The effects of tri-, tetra-, penta-, and hexaphosphates on the crystallization rate of strontium sulfate was studied. It was found that the number of moles adsorbed per gram of strontium sulfate decreases with the increase in the chain length of polyphosphate. Independent of the chain length of the phosphates, each monomer exhibits almost the same effect on the crystallization rate. The effects of the phosphates on the habit of the crystals deposited are also similar to one another. (P.C.H.)

**6802** THE LUMINESCENCE SPECTRA OF TRIPLY-IONIZED DYSPROSIUM AND TERBIUM IN ALKALINE EARTH FLUORIDES. Eiichi Iwase and Seijiro Nishiyama (Inst. of Physical and Chemical Research, Tokyo). Bull. Chem. Soc. Japan, 36: 1179-83(Sept. 1963).

The luminescence spectra of dysprosium(III) and terbium(III) ions were measured in the cubic field ($O_h^5$) of calcium fluoride, strontium fluoride, and barium fluoride under excitation by cathode-ray-bombardment. Displacement of the luminescence bands of dysprosium(III) ion was studied with relation to the matrices mentioned, a blue shift being observed, with 25 and 22 bands as the matrix was changed in successive sequences of calcium fluoride to strontium fluoride and strontium fluoride to barium fluoride, respectively. Similarly, this was the case with 35 bands of the terbium(III) luminescence when, the matrix was changed from calcium fluoride to strontium fluoride, and with 33 bands for that from strontium fluoride to barium fluoride. The magnitude of the relative crystalfield splittings $\Delta\nu$ of the luminescence bands of dysprosium(III) and terbium(III) ions is reported in relation to the increasing strength of the crystal field. For the dysprosium(III) luminescence, the crystalfield splittings observed in the 6F11/2 → 6H11/2, 6F11/2 → 6H13/2 and 6F11/2 → 6H15/2 transitions had a tendency to increase in the matrix-sequence barium fluoride, strontium fluoride, and calcium fluoride. In the case of the terbium(III) luminescence, variations similar to that found in the dysprosium(III) luminescence took place in the crystalfield splittings of the 5D4 → 7F3, 5D4 → 7F4, 5D4 → 7F5, 5D3 → 7F2, 5D3 → 7F3, and 5D3 → 7F5, transistions, while the reverse was the case with the 5D4 → 7F6 and 5D3 → 7F4 transitions. (P.C.H.)

**6803** THE LUMINESCENCE SPECTRA OF TRIPLY-IONIZED RARE EARTHS IN THE CALCINATION PRODUCTS OF SOME MAGNESIUM COMPOUNDS. Eiichi Iwase and Seijiro Nishiyama (Inst. of Physical and Chemical Research, Tokyo). Bull. Chem. Soc. Japan, 36: 1183-7(Sept. 1963).

The luminescence spectra of samarium(III), europium(III), terbium(III), and dysprosium(III) ions embedded in the calcination products of $Mg(NO_3)_2 \cdot 6H_2O$, $MgSO_4 \cdot 7H_2O$ and $MgCl_2 \cdot 6H_2O$ were studied under excitation by cathode-ray bombardment at room temperature. Calcination of the ions was carried out either at about 900°C for 30 min or by further heating at about 1800°C for 5 min. The luminescence spectrum of each of the rare earth ions in magnesium oxide matrix was obtained in its pure form in the case of the calcination products derived from $Mg(NO_3)_2 \cdot 6H_2O$. A number of distinguishing diffuse luminescence bands were observed arising from the sulfate component remaining in the calcination products derived from $MgSO_4 \cdot 7H_2O$. Calcination products derived from $MgCl_2 \cdot 6H_2O$ had a composition very near that of magnesium oxide and contained only a small amount of chlorine. When the triply-ionized rare

earths were embedded in the calcination products, several intense and sharp luminescence bands were found that cannot be ascribed to those observed in pure magnesium oxide, but presumably result from their chlorine content. The luminescence spectra of the triply-ionized rare earths embedded in the matrices derived from the calcination of $MgSO_4 \cdot 7H_2O$ and $MgCl_2 \cdot 6H_2O$ were considered to be constituted of the bands observed in the matrix of pure magnesium oxide and those characteristic of a matrix containing either a sulfate- or chloride-component. As to the intensity of the luminescence of the ions embedded in the matrices of calcined magnesium compounds, the magnitude of variation arising from heat treatment at elevated temperatures may be arranged in the order of rare earth ions with increasing atomic numbers 62 to 66, the most marked decrease being seen in the luminescence of samarium(III) ions with the smallest atomic number (62), and the most marked increase, in that of dysprosium(III) ions with the largest atomic number (66). (P.C.H.)

**6804** METHOD OF PREPARATION AND PROPERTIES OF SOME RARE EARTH CHELATE COMPOUNDS. V. S. Khomenko and V. V. Kuznetsova (Belorussian State Univ., USSR). Doklady Akademii Nauk Belorussk. SSR, 7: 610-13[1963].

A modified method for preparing rare earth chelate compounds in pure crystalline form is presented. First, a solution of 100 mg of the rare earth nitrate in 2 ml of ethanol is prepared. A second solution, consisting of 230 mg of dibenzoyl methane and 26 mg of sodium hydroxide in 10 ml of ethanol, is slowly added to the first with stirring. After several hours, the crystal chelate is formed. The proportions cited are for Europium. The amount of alkali is varied for the other rare earth metals. (OTS)

**6805** A COMPUTER ANALYSIS OF STATIC AND DYNAMIC MODELS OF THE HAFNIUM FLUORIDE COMPLEXES EXTRACTED BY TRI-n-OCTYLPHOSPHINE OXIDE. Louis P. Varga and David N. Hume (Oklahoma State Univ., Stillwater and Massachusetts Inst. of Tech., Cambridge). Inorg. Chem., 3: 77-80(Jan. 1964).

Distribution measurements at 25° between fluoride-containing trace hafnium solutions in 3 M perchloric acid and 0.01 and 0.05 M tri-n-octylphosphine oxide (TOPO) in cyclohexane were interpreted in terms of both static and dynamic models of the hafnium-containing TOPO adducts extracted into the organic phase. The static model which best fits the experimental data assumed the extraction of four species: $Hf(ClO_4)_4 \cdot TOPO$, $Hf(ClO_4)_4 \cdot 2TOPO$, $HfF_2(ClO_4)_2 \cdot TOPO$, and $HfF_2(ClO_4)_2 \cdot 2TOPO$. The dynamic model assumed a labile solvate equilibrium between the hafnium species and TOPO to give average compositions for two extracting species of $Hf(ClO_4)_4 \cdot 1.5TOPO$ and $HfF_2(ClO_4)_2 \cdot 1.5TOPO$. This model concedes the inability and lack of necessity of the equilibrium measurements to distinguish between labile solvate species and treats data in a practical fashion by assuming only the two extractable species. This was the most satisfactory model both from the standpoint of the number of parameters required to explain the data and the goodness of fit. The distribution coefficients for all assumed species were determined and these were used to calculate the over-all formation constants of the hafnium fluoride system. (auth)

**6806** ZIRCONIUM COMPLEXES IN AQUEOUS SOLUTION. III. ESTIMATION OF FORMATION CONSTANTS. B. J. Intorre and A. E. Martell (Clark Univ., Worcester, Mass. and Illinois Inst. of Tech., Chicago). Inorg. Chem., 3: 81-7(Jan. 1964).

Data obtained from potentiometric titration of the zirconium–ethylenediaminetetraacetate 1:1 (Zr–EDTA 1:1) chelate at different concentrations were used to estimate the dimerization constant, $K_D$, and hydrolysis constant, $K_a$, of the monomeric chelate. Potentiometric data were also used to determine equilibrium constants for the reaction of disodium 1,2-dihydroxybenzene-3,5-disulfonate (Tiron) with the Zr–EDTA 1:1 chelate to form the Zr–EDTA–Tiron 1:1:1 chelate. Spectrophotometric measurements were used to estimate the formation constant of the zirconium–Tiron 1:1 and zirconium–nitrilotriacetate 1:1 chelates and to set limits on the Zr–EDTA 1:1 chelate formation constant. Some data are reported for the corresponding hafnium chelate systems. (auth)

**6807** THE MECHANISM OF SUBSTITUTION REACTIONS AT OCTAHEDRAL SITES. III. DEUTERIUM ISOTOPE EFFECTS IN THE ACID AND BASE HYDROLYSIS OF ANIONOPENTAAMMINECHROMIUM(III) IONS. M. Parris and W. J. Wallace (Univ. of Alberta, Edmonton). Inorg. Chem., 3: 133-9(Jan. 1964).

The hydrolysis of $Cr(NH_3)_5X^{2+}$, where X = $Cl^-$, $Br^-$, $I^-$, and $SCN^-$, was examined in solvents containing varying proportions of $H_2O$ and $D_2O$. For X = $SCN^-$, $Cl^-$, $Br^-$, and $I^-$, $k_D/k_H$ takes on the values 0.43, 0.60, 0.95, and 1.51, respectively. The interpretation of these effects suggests a transition state that intimately involves one or more water molecules and is strongly polar but does not involve separated ions. In basic solution, the corresponding ratio of rate constants for the chloro complex is 1.37. The interpretation of the data suggests that the transition state for the base hydrolysis involves direct interaction and charge transfer between the hydroxide ion and the metal ion. The exchange of hydrogen between the solvent and the ammonia molecules of the solute was also measured. (auth)

**6808** CRYSTALLINE HYDROUS ZIRCONIA. A. Clearfield (National Lead Co., Niagara Falls, N. Y.). Inorg. Chem., 3: 146-8(Jan. 1964).

Crystalline hydrous zirconia was prepared, and studies were made on its composition and structure. Crystallites as large as 120 Å were obtained. Close agreement between the interplanar spacings of the hydrous oxides and those of the calcined products indicates that within the crystallites the composition must be close to $(ZrO_2)_n$. However, the crystalline hydrous zirconias still contain significant amounts of coordinated water and hydroxyl groups. Thus, the crystalline, hydrous zirconias are considered to be hydrated oxo-hydroxides. (P.C.H.)

**6809** INVESTIGATION OF COORDINATED POLYMERS. III. PROPERTIES OF INTRACOMPLEX BERYLLIUM CONTAINING POLYMER WITH 4,4′-BIS(ACETOACETYL)DIPHENYLOXIDE. M. G. Vinogradov, S. V. Vinogradova, Yu. A. Davidovich, and V. V. Korshak (Inst. of Organic Compounds, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 11, 2023-7(Nov. 1963). (In Russian)

Studies of intracomplex beryllium containing 4,4′-bis(acetoacetyl)diphenyl oxide polymer showed that the polymer is stable up to 280°C. The depth and rate of polymer disintegration at high temperatures is higher in the air media than nitrogen. Intracomplex polymer does not alter its properties after 3 to 4 hours of heating at 300 to 325°, following 2 hrs of exposure to 350°C it acquires a tridimensional structure. Effects of various reagents were also analyzed. (R.V.J.)

**6810** COPRECIPITATION OF URANIUM(VI) WITH IRON HYDROXIDE UNDER COMPLEXING CONDITIONS. A. I. Novikov, V. I. Tikhomirova (Tadzhik State Univ.,

USSR). Izv. Vysshykh Uchebn. Zavedenii, Khim. i Khim. Technol., 6: 377-84(1963).

Studies were made on the coprecipiatation of various quantities of uranium (10 μg, 1 mg, and 10 mg in 20 ml of solution) with iron hydroxide (0.1 mg-atom of iron). The studies were conducted over a wide pH range in a 1 M solution of ammonium nitrate with varied uranium concentration, and coprecipitation of uranium with iron hydroxide. The coprecipitation of uranium with iron hydroxide is a complex process dependent on pH, uranium concentration, and salt composition of the solution. (OTS)

**6811** SOLVENT DEUTERIUM ISOTOPE EFFECTS ON ACID-BASE EQUILIBRIA. Pentti Salomaa, Larry L. Schaleger, and F. A. Long (Cornell Univ., Ithaca, N. Y.). J. Am. Chem. Soc., 86: 1-7(Jan. 6, 1964).

The glass electrode affords precision measurements of acidities in mixed $H_2O-D_2O$ solvents. Using electrodes standardized for $H_2O$ solutions, the pL, the generalized equivalent of pH (where L includes all the isotopically different hydrogen ions), in solvent of deuterium atom fraction n is given by pL = (meter reading) + 0.3314n + $0.0766n^2$. Ionization constants in the mixed solvents were determined for phosphoric and arsenic acids and for the aqueous solvent itself. For water, $pK_n - pK_H = 0.663n + 0.146n^2$. The apparent failure of the Gross equation to fit the data in these cases is shown to be due to the fact that the simple equation does not hold for polybasic acids. General equations, depending on the number and character of exchangeable protons in the acid and conjugate base, were derived with the aid of the rule of the geometric mean and without added assumptions about fractionation factors. Equations in which the solvated lyon is treated as $L_3O^+$ and that employ a value of the exchange constant of L = 11.0 satisfactorily fit all available data, whereas the linear equation for unspecified solvation fails in the case of the ionization of water. Several kinetic applications of mixed solvent studies are discussed, including acid-catalyzed ester hydrolysis. (auth)

**6812** ELECTRON DIFFRACTION STUDY OF THE MOLECULAR STRUCTURES OF SULFUR TETRAFLUORIDE ($SF_4$) AND THIONYL TETRAFLUORIDE ($SOF_4$). K. Kimura and S. H. Bauer (Cornell Univ., Ithaca, N. Y.). J. Chem. Phys., 39: 3172-8(Dec. 15, 1963).

The molecular structures of $SF_4$ and $SOF_4$ in the gaseous state were determined by electron diffraction using sector-microphotometer data. Both molecules were confirmed to have trigonal bipyramidal structures ($C_{2v}$ symmetry), with two nonequivalent sets of F-S bond distances. The bond lengths, in terms of the center of gravity parameter, $r_g$, and the bond angles are given. The polar F-S-F angles are measured along an arc that bisects the equatorial FSF angle. (P.C.H.)

**6813** BOLTZMANN EQUATION AND INVERSE COLLISIONS. II. A MODEL FOR ASSOCIATION AND DISSOCIATION. James T. O'Toole (Princeton Univ., N. J.) and John S. Dahler. J. Chem. Phys., 39: 3214-32 (Dec. 15, 1963).

The techniques of classical nonequilibrium statistical mechanics were applied to a gas that exhibits two distinct types of molecular interaction. The first allows chemical bonding to the extent of dimer formation; the second, impulsive in nature, provides a tractable mechanism for three-body energy exchange. Hydrodynamic equations are derived for each of the two quasicomponents. A formal description of the reaction kinetics was developed that leads to a perturbation method for obtaining corrections to a theory based on an assumption of uniformly canonical distributions. (auth)

**6814** TEMPERATURE AND PRESSURE DEPENDENCE OF THE $Co^{59}$ NUCLEAR RESONANCE CHEMICAL SHIFT. George B. Benedek (Massachusetts Inst. of Tech., Cambridge), Robert Englman, and John A. Armstrong. J. Chem. Phys., 39: 3349-63(Dec. 15, 1963).

The temperature and pressure dependence of the $Co^{59}$ nuclear resonance chemical shift ($\sigma$) in the octahedral cobalt complexes $Co(NH_3)_6^{3+}$, $Co(CN)_6^{3-}$, and $Co(NO_2)_6^{3-}$ were measured in aqueous solution. The pressure and temperature range was 1 to 10,000 kg/cm$^2$ and 3 to 80°C, respectively. From the pressure dependence of $\sigma$ and a theoretical determination of the compressibility of the complexes, the dependence of the crystal-field splitting on the cobalt-ligand distance was deduced. A theory for the explicit temperature dependence of the chemical shift is presented. The fundamental parameters that enter the theory are the 15 normal mode frequencies when the cobalt electrons are in the ground state and when they are in the excited state. While the former quantities are known from the vibrational spectra of these complexes, the latter are unknown. By fitting the theory to the experimental data, it was concluded that, on the average, the vibration frequencies in the $^1T_{1g}$ excited electronic state must be smaller than those in the ground state by about 30% for the cyanide and nitrite complexes and by about 20% for the ammonia complex. A nonlinear dependence of $\sigma$ on the temperature is predicted by the theory and observed experimentally. (auth)

**6815** MÖSSBAUER STUDIES OF IRON ORGANO-METALLIC COMPLEXES. I. IRON TETRACARBONYL COMPLEXES. R. L. Collins and R. Pettit (Univ. of Texas, Austin). J. Chem. Phys., 39: 3433-6(Dec. 15, 1963).

Mössbauer absorption spectra at 78°K were obtained for a series of compounds of the form R:$Fe(CO)_4$, where R includes triphenylphosphine, triethylphosphite, acenaphthalene, trans-cinnamaldehyde, maleic anhydride, syn-syn-1,3-dimethyl-π-allyl cation, syn-1-methyl-π-allyl cation, π-allyl cation, and $I_2$. The isomer shift increases and the electric quadrupole splitting decreases regularly through this series. The effect is explained in terms of the extent of forward coordination of the ligands, and so forms a basis for measuring Lewis basicity of ligands. The compound $I_2$:$Fe(CO)_4$ unexpectedly follows the trend, suggesting that appreciable bonding remains between iodine atoms. (auth)

**6816** EFFECT OF ISOTOPIC SUBSTITUTION ON THE DIPOLE MOMENT OF MOLECULES OF SYMMETRICAL CONFIGURATION. Francis A. Gangemi (Catholic Univ. of America, Washington, D. C.). J. Chem. Phys., 39: 3490-6(Dec. 15, 1963).

The effects of isotopic substitution on the dipole moment of $O^{16}C^{12}O^{18}$ and $CH_3D$ were calculated. A normal coordinate treatment is carried out for these two molecules using a simplified form for the force fields as an approximation to the general quadratic force fields of both $CO_2$ and $CH_3D$. It is assumed therefore that the omitted terms play a negligible part in dipole moment calculations. The vibrational wavefunctions for the nuclear skeletons of the systems are calculated, including the effect of the cubic terms in the potential function as perturbations to the simple harmonic wavefunctions. The shift from the equilibrium separation of the atoms is then calculated by taking the quantum mechanical average values of the position coordinates. Finally, the dipole moment is given by the product $\Delta\mu = \partial\mu/\partial r\,\langle\Delta r\rangle_{Av}$, where $\partial\mu/\partial r$ is the change in bond moment with respect to internuclear distance, which is de-

termined from experiment, and $\langle \Delta r \rangle_{Av}$ is the shift or displacement from the equilibrium separation of the nuclei. The calculations yielded the following results: for $O^{16}C^{12}O^{18}$, a permanent dipole moment of the order of $10^{-3}$ D, and for $CH_3D$, a permanent dipole moment of the order of $10^{-3}$D, for the vibrational ground states. (P.C.H.)

**6817** INFRARED SPECTRA OF HF–DF MIXED CRYSTALS AND THE STRUCTURE OF HYDROGEN FLUORIDE. M. L. N. Sastri and D. F. Hornig (Princeton Univ., N. J.). J. Chem. Phys., 39: 3497-3502(Dec. 15, 1963).

The infrared spectra of HF–DF mixed crystals were studied throughout the composition range. Unlike HF, the spectrum of pure DF shows only the two peaks in the stretching region, which are characteristic of the zigzag chain structure found by x-ray studies for HF and spectroscopically for HCl and HBr. The spectrum of pure HF shows the anomalous features previously reported. From the mixed crystal spectra it is clear that there is only one kind of site and one kind of strongly interacting pair in either HF or DF. A resolved peak due to triplets of HF (in DF) and of DF (in HF) was observed. It was concluded that the extra peaks in pure HF probably arise from lattice combinations; in any case all of the major features of the spectra are accounted for by the zigzag chain structure of symmetry $D_{2h}^{16}$-Pmnb. It has not yet been possible to interpret the lattice spectrum in detail. (auth)

**6818** DECOMPOSITION OF CHEMICALLY ACTIVATED ETHYL-$d_1$ RADICALS. J. H. Current (Univ. of California, Berkeley), B. S. Rabinovitch, C. A. Heller, and A. S. Gordon. J. Chem. Phys., 39: 3535-6(Dec. 15, 1963).

Values for decomposition/stabilization (D/S) used in a previous study on the decomposition of hot ethyl-$d_1$ radicals (Heller and Gordon, J. Chem. Phys. 36: 2648(1962)) were corrected. (P.C.H.)

**6819** SORPTION FROM DILUTE AQUEOUS ELECTROLYTE SOLUTIONS BY ZIRCONIA. D. P. Benton, G. A. Horsfall, and S. K. Nicol (Battersea Coll. of Tech., London). J. Chem. Soc.: 5067-72(Nov. 1963).

The extent of sorption by zirconia from dilute aqueous solutions of sodium chloride and hydrochloric and nitric acid, and a number of mixtures of these electrolytes, was studied by conductometric and potentiometric measurement of concentration loss from solution. Sorption of sodium ion was not detected from neutral or acid solutions. Sorption from nitric acid is rather less in extent than from hydrochloric acid at corresponding concentrations. From solutions containing both these acids, anion sorption depends on both pH and anion fraction. Electrokinetic properties of zirconia in these solutions were studied by microelectrophoresis. Zirconia is negatively charged in water, charge reversal occurring in nitric acid and hydrochloric acid solutions at concentrations $\sim 10^{-4}$ and $\sim 10^{-3}$N, respectively. (auth)

**6820** LUMINESCENT BEHAVIOR OF THE RARE EARTHS IN YTTRIUM OXIDE AND RELATED HOSTS. K. A. Wickersheim and R. A. Lefever (General Telephone and Electronics Labs., Inc., Palo Alto, Calif.). J. Electrochem. Soc., 111: 47-51(Jan. 1964).

The absorption, excitation, and fluorescence spectra of $Y_2O_3$:Eu are presented and interpreted. The high luminescent efficiency of this material and its unusual performance at elevated temperatures are discussed. The comparative behavior of other rare earths in yttrium oxide and of the rare earths in certain other oxides of yttrium and lanthanum are also discussed briefly. (auth)

**6821** RECENT RESEARCH ON THE TRANSURANIUM ELEMENTS. Glenn T. Seaborg (Atomic Energy Commission, Washington, D. C.). J. Franklin Inst., 276: 459-74 (Dec. 1963).

A brief review is presented on the discovery and developments in transuranium elements. (P.C.H.)

**6822** FORMATION AND PROPERTIES OF SOLID SOLUTIONS OF ZIRCONIUM DIOXIDE WITH OXIDES OF RARE-EARTH ELEMENTS. E. K. Keler and A. B. Andreev (Inst. of Silicate Chemistry, Academy of Sciences USSR). Ogneupory, No. 5, 224-31(May 1963).

The results of a study of zirconium dioxide-base materials in the form of solid solutions with $CeO_2$, $Y_2O_3$, and $La_2O_3$ in comparison with the properties of the previously studied solid solution $ZrO_2$–CaO are presented. Pressed samples in the form of pellets were used for chemical and x-ray diffraction studies and rectangular prisms were used for dilatometric investigation. Dielectric loss factor and permeability were determined on samples sintered at 1400–1750°C in a kerosene-fired furnace. Phase composition was based on selective dissolving of the reaction products in boiling hydrochloric acid. X-ray diffraction patterns of 21 samples of various compositions, which were subjected to various sintering temperatures are shown. Graphs are used to show variation of linear dimensions of 17 samples during heating. Molar compositions of the initial mixtures, interplanar spacings of $ZrO_2$–$CeO_2$ solid solutions, and ceramic properties (moisture absorption, specific volume, porosity, compressive strength) of $ZrO_2$ with other oxides at various roasting temperatures are tabulated, along with elastic properties (shear modulus, modulus of elasticity, Poisson's ratio), electrical and physical properties (porosity, dielectric loss factor and permeability, Mohs hardness, coefficient of thermal expansion from 0° to 1200°C) and the results of chemical phase analysis. The results are discussed in light of production of new, highly refractory materials from solid solutions of $ZrO_2$ with other oxide components. Special advantages of certain oxide pairs, as well as limitations of cerium-containing compounds as refractory materials, in view of the possibility of reducing $CeO_2$ to $Ce_2O_3$, are pointed out. (OTS)

**6823** APPLICATION OF SPIN-WAVE THEORY TO EuS. S. H. Charap and E. L. Boyd (International Business Machines Corp., Yorktown Heights, N. Y.). Phys. Rev., 133: A811-18(Feb. 3, 1964).

Magnetization data for EuS powder in zero field and at liquid-helium temperatures were obtained by nuclear magnetic resonance of both the $Eu^{151}$ and $Eu^{153}$ nuclei. These data are considered simultaneously with those for the specific heat of EuS powder obtained by McCollum and Callaway in order to provide a more definitive application of the spin-wave theory to this material. The theory is that given by Holstein and Primakoff and special attention is given to the effects of magnetic dipolar coupling on the spin-wave energy and moment. The calculation was carried out by summation over the exact Brillouin zone. Values of the nearest-neighbor exchange interaction $J_1$ and second-neighbor exchange $J_2$, as well as an effective field H, which simultaneously produced reasonable agreement between calculation and experiment, are $J_1 = 0.20 \pm 0.01$°K, $J_2 = -0.08 \mp 0.02$°K and $H = 4.0 \pm 0.2$ kOe. These values are fairly consistent with other parameters known for EuS. (auth)

**6824** BORATING REFRACTORY TRANSITION METALS. A. P. Epik (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, Ukrainian SSR). Poroshkovaya

Met., Akad. Nauk Ukr. SSR, No. 5, 21-7(Sept.-Oct. 1963). (In Russian)

An investigation was made on the effect of the conditions of borating Ti, Zn, Nb, Ta, Mo, and W on the thickness, structure, phase composition and other properties of diffusive boride layers. The results of metallographic, x ray, and chemical analyses of diffusion layers are presented, and their phase composition and microhardness are given. The parameters and equations of boron diffusion were found in the indicated metals. (auth)

**6825** URANYL ION COORDINATION. John O. Edwards and Jeffrey A. Stritar (Brown Univ., Providence). Science, 142: 1651(Dec. 27, 1963).

With a noncomplexing anion such as perchlorate ion, the uranyl ion coordinates to five monodentate oxygen ligands. The relation of this observation to the work of Evans is discussed. (auth)

**6826** NEW DATA FROM AN X-RAY STUDY OF PHASE TRANSFORMATIONS IN SODIUM NIOBATE. I. G. Ismailzade (Mamedaliev Inst. of Petrochemical Processes, Academy of Sciences, Azerbaidzhan SSR). Soviet Phys.-Cryst. (English Transl.), 8: 284-7(Nov.-Dec. 1963).

An x-ray study was made on phase transformations in polycrystalline sodium niobate. A new phase transformation was discovered at 570°C. It is shown that, in agreement with the optical data, the subcell of $NaNbO_3$ in the range 360–510°C has a pseudomonoclinic symmetry, at 520–635°C tetragonal, and above that cubic. (auth)

**6827** DETERMINATION OF THE POSITION OF CARBON IN CEMENTITE BY THE NEUTRON DIFFRACTION METHOD. B. G. Lyashchenko and L. M. Sorokin (Bardin Central Scientific Research Inst. of Ferrous Metallurgy, Academy of Sciences, USSR). Soviet Phys.-Cryst. (English Transl.), 8: 300-4(Nov.-Dec. 1963).

The position of the carbon atoms in the crystal lattice of cementite $Fe_3C$ (space group $D_{2h}^{16}/P_{bnm}$) was determined by the neutron diffraction method. It was found that the so-called c model is realized with the carbon parameters $\lambda = 0.46$ and $\mu = -0.146$, according to which each carbon atom is surrounded by six iron atoms, forming a trigonal prism with the following Fe–C distances: 2.16; 2.16; 1.90; 1.90; 1.93; and 1.85 Å. (auth)

**6828** HIGH-RESOLUTION N.M.R. SPECTRA IN ELECTRIC FIELDS. A. D. Buckingham (Oxford Univ.) and J. A. Pople. Trans. Faraday Soc., 59: 2421-30(Nov. 1963).

A general method of calculating high-resolution nuclear magnetic resonance spectra of polar fluids in electric fields is described. The partial orientation of the molecular electric dipole moments in a strong electric field modifies the averaging of the tensors representing nuclear magnetic shielding and spin-spin coupling. An effective Hamiltonian for polarized fluids is deduced and used to predict spectral changes in certain standard types of n.m.r. spectra involving spin-½ nuclei. Equivalent nuclei are found to produce splittings proportional to the inverse cube of their separation. (auth)

**6829** ELECTROCHEMICAL STUDIES IN THE RARE EARTH SERIES. PART 3. CONDUCTANCES OF SOME 3-3 ELECTROLYTES IN WATER AND DIOXAN + WATER. H. S. Dunsmore, T. R. Kelly, and G. H. Nancollas (Glasgow Univ.). Trans. Faraday Soc., 59: 2606-11(Nov. 1963).

Conductance measurements are reported for dilute solutions of $LaCo(CN)_6$ in water and in 10 and 20 wt. % dioxane + water, and for the ferricyanides of La, Nd, and Gd in water. Dissociation constants have been evaluated and the calculation of $\alpha$, the distance of closest approach of ions, for $LaCo(CN)_6$ has shown that a particular theory of ion association adequately describes the behavior of this electrolyte in the range of dielectric constants studied. The close similarity in the dissociation constants confirms the prediction that one would not expect to find large differences for a series of lanthanide salts in the same solvent. (auth)

**6830** STRUCTURAL ANALYSIS OF ION SEMI-PERMEABLE MEMBRANES BY Co-ION UPTAKE AND DIFFUSION STUDIES. J. M. Crabtree and E. Glueckauf (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Trans. Faraday Soc., 59: 2639-54(Nov. 1963).

Three different strongly basic exchangers with similar co-ion uptake behavior have very different co-ion diffusion characteristics. Not only are there differences in the order of magnitude of the co-ion permeabilities P at the same external electrolyte concentration c, but also marked differences in the shape of the P-c curves, which can be interpreted in terms of the internal micro-structure of the (inhomogeneous) membrane. Other structural details can be elucidated from the fact that polyvalent co-ions are more strongly excluded from local regions of high counter-ion concentration than are monovalent co-ions, and so lead to different P-c relations. Furthermore there was observed, especially for polyvalent ions, a great difference between the mechanisms of steady-state through-diffusion and of transient diffusion out of a saturated membrane, which also permits interpretation in terms of internal structure. The details obtained by the mathematical analysis of the diffusion data agree with, and go considerably beyond, what can be ascertained by electron microscopy. (auth)

**6831** THE PREPARATION AND PROPERTIES OF POTASSIUM MONOFLUOROTRIOXYURANATE (VI) $KUO_3F$. G. Mitra (King's Coll., Wilkes-Barre, Penna.). Z. Anorg. Allgem. Chem., 326: 98-100(Dec. 1963).

The potassium salt of the monofluorotrioxyuranate ion is described. The compound is prepared by fusing uranium trioxide and potassium fluoride. It can form addition compounds with oxalic acid, acetic acid, etc. (auth)

**6832** INVESTIGATION OF DICHLORIDES OF THE RARE-EARTH ELEMENTS. O. G. Polyachenok and G. I. Novikov. Zh. Obshch. Khim., 34: 2797(Aug. 1963).

The salient features of melting point diagrams of the systems $SmCl_3$–Sm, $ScCl_3$–Sc, and $YCl_3$–Y are discussed. Methods of preparation of the pure dichlorides are given for $SmCl_2$, $EuCl_2$, and $YbCl_2$. Saturated vapor pressure measurements in the systems $LaCl_3$–La, $PrCl_3$–Pr, $NdCl_3$–Nd, $YCl_3$–Y, and $ScCl_3$–Sc are discussed. Values are given for enthalpy and entropy for the process of disproportionation of the dichloride into the trichloride and the metal for $NdCl_2$ and $PrCl_2$, as well as the entropies of formation of $NdCl_2$, $NdCl_3$, and $ScCl_2$. (OTS)

**6833** PRODUCTION AND CERTAIN PROPERTIES OF LANTHANUM PHOSPHIDE. G. V. Samsonov and S. N. Endrzheevskaya (Inst. of Powder Metallurgy and Special Alloys, Academy of Sciences, Ukrainian SSR). Zh. Obshch. Khim., 34: 2803-4(Sept. 1963).

The formation of lanthanum monophosphide by reaction of phosphine, $PH_3$, with metallic lanthanum and by reduction of lanthanum oxide, $La_2O_3$, with phosphine was investigated. The second method, based on the reaction: $La_2O_3 + 2PH_3 = 2LaP + 3H_2O$, was found to be more convenient, and the conditions of the process were studied. A summary table shows how the chemical composition of the reaction product varies with phosphidization (variations of temperature and time). The reaction was proceeded most actively at temperatures above 1200–1250°C, and takes three to five hours at 1300°. LaP has a face-centered cubic lattice of the NaCl

type with a period a = 6.016 angstroms, density 5.18 g/cm³. Characteristic features of the chemical analysis of LaP are indicated. (OTS)

**6834** SOME ZIRCONIUM COMPOUNDS AND REGIONS OF THEIR APPLICATION. P. P. Budnikov and A. M. Cherepanov. Zh. Vses. Khim. Obshchestva im. D. I. Mendeleeva, 8: 141-8(1963).

The properties and uses of zirconium compounds, principally zirconium dioxide ($ZrO_2$) and zircon ($ZrSiO_4$), are reviewed. The natural occurrence of zircon is discussed. Information is given on the industrial production of pure $ZrO_2$, characteristic impurities, crystalline modifications (monoclinic and tetragonal (pseudocubic)), lattice parameters, polymorphic transformations, and the action of various additives on the stabilization of the pseudocubic modification of $ZrO_2$. Data are presented on the hardness, specific gravity, melting point, vapor pressure, strength, modulus of elasticity, and specific heat of sintered $ZrO_2$. The characteristics of stabilized $ZrO_2$ (density, porosity, coefficient of heat conduction, coefficient of linear thermal expansion), are discussed and tabulated. Data are given on the electrical properties of $ZrO_2$ and its behavior under the action of radiation. The chemical properties are discussed, and indications of possible and already developed areas of technological application are given. The phase diagram of the $ZrO_2-SiO_2$ system, which is the physicochemical base of zirconium refractory materials, is presented and discussed. A comparatively new and significant region of the use of zircon, for the application of highly refractory, heat-stable and electrically nonconducting coatings on certain metallic parts for protection from corrosion and erosion under rigorous service conditions, is indicated. (OTS)

**6835** THERMODYNAMIC AND MAGNETIC PROPERTIES OF THE RARE EARTH CHALCOGENIDES. Edgar F. Westrum, Jr. (Univ. of Michigan, Ann Arbor). p.310-50 of "Progress in the Science and Technology of the Rare Earths. Vol. I." London, Pergamon Press Ltd., [1963].

A review is presented on the magnetic and thermodynamic properties of rare earth compounds with oxygen, sulfur, selenium, and tellurium (chalcogenides). 258 references are included. (P.C.H.)

**6836** CRYSTAL CHEMISTRY OF THE RHOMBOHEDRAL $MO_3 \cdot 3R_2O_3$ COMPOUNDS. E. A. Aitken, S. F. Bartram, and E. F. Juenke (General Electric Co., [Cincinnati]). 24p. (CONF-45-1)

From American Ceramic Society Basic Science Division Meeting, Washington, D. C., Oct. 1963.

Phase relationship studies on the $UO_3-UO_3-Y_2O_3$ ternary system showed the formation of face-centered cubic solid solutions, body-centered cubic solid solutions, and two rhombohedral phases. Both rhombohedral phases exist at a definite chemical composition, one of which (Rh I) can be expressed by the formula $(U_x, Y_{1-x})O_{12}$ where x = 1 to 3.4. For values of x greater than 2.8, low temperature oxidation produces a second rhombohedral structure (Rh II) of composition $(U_y, Y_{8-y})O_{15}$ where y = 2 to 3.9. The rhombohedral I crystal structure is characteristic of a large family of new compounds formed between rare earth oxides and $UO_3$, $WO_3$, or $MoO_3$. Crystallographic data on these isostructural compounds are presented. The influence of ionic size and valence upon the formation and stability of this structure are discussed. (auth)

**6837** METHOD OF PRODUCING AN ANHYDROUS CRYSTALLINE ZIRCONIUM TETRAACETATE. (to Th. Goldschmidt AG). British Patent 946,318. Jan. 8, 1964. Priority date Jan. 29, 1960, Germany.

A method of producing anhydrous crystalline zirconium tetraacetate is described. A solution of monochlorozirconyltriacetate-acetic acid complex in a mixture of acetic acid and acetic anhydride is heated so as to drive off acetic acid and hydrogen chloride. The resulting zirconium tetraacetate is precipitated in the remaining acetic anhydride, recovered, and dried. (M.C.G.)

## Organic Chemistry

**6838** (IDO-11008) THERMODYNAMIC PROPERTIES OF BIPHENYL AND THE ISOMERIC TERPHENYLS. Final Report, March 1961–October 31, 1963. J. A. Ellard and W. H. Yanko (Monsanto Research Corp. Dayton Labs., Ohio). Contract AT(10-1)-1088. 132p.

Calorimetric and PVT measurements of pure biphenyl, o-terphenyl, and m-terphenyl were made and utilized to calculate the thermodynamic networks of the three fluids from 156 to 1000°F, 235 to 965°F, and 290 to 950°F, respectively. The thermodynamic properties of each fluid are expressed in tabular form and as Mollier Charts. A new PVT apparatus for rapid measurements at high temperatures was constructed, and PVT measurements of the superheated vapors are reported for the first time. The PVT properties of the saturated vapor and liquid and of the compressed liquid are reported to at least 500°C (932°F) for each fluid. A precision isothermal drop calorimeter of large capacity was designed and built, and the liquid heat contents of the three fluids were measured to 824°F for biphenyl and to 752°F for the terphenyls. Equations of state and liquid heat content, vapor pressure, and liquid density equations were derived for each fluid. Heats of fusion of biphenyl and m-terphenyl were also measured. Theoretical maximum cycle efficiencies were calculated for each fluid in simple heat engines. (auth)

**6839** (TID-19838) TRITIUM AND NITROGEN-15 ISOTOPE EFFECTS IN THE DECOMPOSITION OF p-NITROPHENETHYLTRIMETHYLAMMONIUM IODIDE. Ernest M. Hodnett and John J. Sparapany (Oklahoma State Univ., Stillwater). [nd]. Contract AT(11-1)-1049. 15p.

The isotope effects of $T_2$ and $N^{15}$ on the kinetics of decomposition of $NO_2C_6H_4CH_2CH_2N(CH_3)_3I$ were studied in both aqueous and nonaqueous solutions. The aqueous solutions were buffered at pH values from 4.6 to 7.0, while the nonaqueous solutions were solutions of formamide and N,N-dimethylformamide in absolute ethanol. First-order kinetics were obtained in all reactions, and the active agent was hydroxide ions in aqueous solutions and formamide or N,N-dimethylformamide in alcoholic solutions. The results indicate the formation of an activated complex $[NO_2C_6H_4CH-(HB)CH_2-N(CH_3)_3]^+$. (D.L.C.)

**6840** NIOBIUM(IV) COMPOUNDS CONTAINING ETHOXIDE: $[NbCl(OC_2H_5)_3(C_5H_5N)]_2$ AND $Nb(OC_2H_5)_4$. R. A. D. Wentworth and C. H. Brubaker, Jr. (Michigan State Univ., East Lansing). Inorg. Chem., 3: 47-50(Jan. 1964).

Investigations of niobium(IV) solutions in ethyl alcohol led to the preparation of two diamagnetic compounds, $[NbCl(OC_2H_5)_3(C_5H_5N)]_2$ and $Nb(OC_2H_5)_4$. The former is prepared by the addition of pyridine to niobium(IV) chloride solutions in ethyl alcohol. The structure of the dimer is thought to involve chloride bridging on the basis of its chemical properties. $Nb(OC_2H_5)_4$ is prepared by the reaction of $NaOC_2H_5$ with $[NbCl(OC_2H_5)_3(C_5H_5N)]_2$. Both compounds are readily converted to $(C_5H_6N)_2[Nb(OC_2H_5)Cl_5]$. (auth)

**6841** ISOTOPE EFFECTS ON INTERNAL FREQUENCIES IN THE CONDENSED PHASE RESULTING FROM INTERACTIONS WITH THE HINDERED TRANS-

LATIONS AND ROTATIONS. THE VAPOR PRESSURES OF THE ISOTOPIC ETHYLENES. Marvin J. Stern, W. Alexander Van Hook, and Max Wolfsberg (Brookhaven National Lab., Upton, N. Y. and Columbia Univ., New York). J. Chem. Phys., 39: 3179-96(Dec. 15, 1963). (BNL-6967)

Interaction of the hindered translations and rotations with the internal vibrations in the condensed phase leads to isotope-dependent shifts of the internal frequencies. This isotope dependence is a necessary consequence of the fact that the coordinates representing the translations and rotations of the molecule as a whole are, in general, isotope dependent. The external-internal interaction was investigated and the $XH_2$ system was employed as a simple example to demonstrate the nature of the interaction. It is shown that the experimentally determined vapor pressures of the isotopic ethylenes may be rationalized when the external-internal interaction is taken into account. A force field based on a simple cell model for liquid ethylene was obtained and yields good agreement with the experimentally determined vapor-pressure isotope effects. The force field, while not unique, fits (and is in fact partially based on) other available data on liquid ethylene. (auth)

**6842** HYDRATION EQUILIBRIA OF ALIPHATIC ALDEHYDES IN $H_2O$ AND $D_2O$. L. C. Gruen and P. T. McTigue (Univ. of Melbourne). J. Chem. Soc.: 5217-23 (Nov. 1963).

Hydration equilibrium constants for acetaldehyde, propionaldehyde, n- and iso-butyraldehyde, and chloral in $H_2O$ and $D_2O$ were measured in the temperature range 25–90°C. The equilibrium constant for formaldehyde was determined in $H_2O$ over the same temperature range. The effects of added electrolytes on the activity coefficients of the hydrates and free aldehydes were also investigated. (auth)

**6843** PREPARATION OF TRITIO-CHOLECALCIFEROL. (TRITIATED VITAMIN $D_3$). C. T. Peng (Univ. of California, San Francisco). J. Pharm. Sci., 52: 861-4 (Sept. 1963).

Cholecalciferol was tritiated by exposure to tritium gas at −198° (liquid N). Pure tritiated vitamin $D_3$ with a specific activity of 216 μC/mg was obtained following equilibration with solvents and purification by successive recrystallization from acetone at −80° and column chromatography on Florisil until a constant specific activity was achieved. The formation of radiation decomposition products was minimal because of using low temperature during tritiation. A possible explanation for this low temperature effect is given. (auth)

**6844** NUCLEAR MAGNETIC RESONANCE. Richard A. Y. Jones (Univ. of Sheffield, Eng.). Sci. Progr. (London), 51: 198-16(Apr. 1963).

The NMR phenomenon and some of its uses are described. Its application is discussed in structural studies and kinetic problems in organic chemistry, for nuclei other than hydrogen, and in high-resolution and broad-line NMR spectra. Speculations as to future uses are presented. (R.E.U.)

**6845** METHOD FOR THE PRODUCTION OF A FIBROUS ARTIFICIAL ORGANIC POLYMERIC MATERIAL. Ole-Bendt Rasmussen. British Patent 941,723. Nov. 13, 1963. Priority date June 25, 1959, Denmark.

A method is given for shaping a high-molecular-weight linear polymer to form a fibrous material which is particularly suited for the production of strong, highly porous yarns. The method comprises imparting molecular orientation to a film or band of the polymer by stretching unidirectionally, splitting the oriented film in the stretching direction into fiber networks, stretching the fiber networks transversely to the splitting direction to expand the meshes of the networks, and finally fixing the expanded networks. Several possible fixation methods are heating, swelling, chemical crosslinking, and irradiation. An example of the method is given using polyethylene. (D.L.C.)

## Radiation Chemistry and Radiochemistry

*Refer also to abstract 7027.*

**6846** (ASD-TR-7-840A(XI)) HYDRAZINE PROCESS DEVELOPMENT. Interim Technical Engineering Report, August through October 1963. R. I. Miller, R. L. Pearson, F. R. Standerfer, H. J. Snyder, L. G. Carpenter, and J. C. Whipple (Aerojet-General Nucleonics, San Ramon, Calif.). Contract AF33(600)-42996. 53p.

Progress is reported in each major area of the Hydrazine Program. The installation and testing of the hydrazine decontamination apparatus are described. Several ion exchange resins were found to be effective in removing $I^{131}$ from hydrazine. The installation and problems of loop components are discussed. (D.L.C.)

**6847** (ORNL-TM-755) GAS RECOMBINATION ACTIVITY OF IRRADIATED SLURRY FROM LOOP L-2-27S. J. P. McBride and W. L. Pattison (Oak Ridge National Lab., Tenn.). Jan. 3, 1964. Contract W-7405-eng-26. 4p.

The catalytic activity for $H_2$ and $O_2$ combination was determined for a slurry prepared from some of the dried, irradiated solids recovered from loop L-2-27S. The specific activity at 280°C based on palladium concentration was at least as high and possibly higher than that obtained with other slurry-palladium catalyst systems which had not been irradiated. (auth)

**6848** (RRL-125) TECHNIQUES OF RADIATION CHEMISTRY. Robert H. Schuler (Mellon Inst. Radiation Research Labs., Pittsburgh). Dec. 3, 1963. Contract AT(30-1)-2310. 37p. (CONF-354-2)

From Accelerator Conference, Boston, Nov. 1963.

Current studies of the mechanistic aspects of radiation chemical reactions involve detailed examination of the effects of dose rate and linear energy transfer on the processes involved in these reactions. Such examination in turn requires accurate absolute measurements of the radiation yields. Some of the problems associated with these measurements are discussed. In recent years the direct observation of intermediate species and the measurement of their reaction rates by spectroscopic and spin resonance methods have played an important role in radiation chemical studies. The application of Van de Graaff methodology to these various types of investigations is described. (auth)

**6849** (TID-19677) RELATIVE EFFECTS OF FAST NEUTRONS AND GAMMA RAYS ON THE RADIOLYSIS OF POLYPHENYLS. Report No. 23. K. L. Hall, M. L. Burrous, N. P. Shiells, and R. O. Bolt (California Research Corp., Richmond). June 30, 1963. Contract AT(04-3)-248. 125p.

Includes Appendices.

The "fast neutron effect" (ratio of neutron and gamma-ray G-values) for the disappearance of starting material was determined for several organic reactor coolant candidates at 600°F. Values for the pure polyphenyls are as follows: biphenyl, 2.1; o-terphenyl, 2.3; m-terphenyl, 2.6; p-terphenyl, 2.2. G-values were determined in two reactor fields, one in which ~95% of the dose (in terphenyl) was due to fast neutrons and a second in which neutrons were

shielded out to provide essentially a pure gamma field. Additional experiments in a spent fuel element gamma source and in a heat source alone confirmed the results of the reactor work. Data are given in terms of rate constants as well as initial partial G-values, and predictions are made for initial overall G-values reported by other workers. The predicted values are then compared with "observed" values from the literature. (auth)

**6850** (TID-19902) THE INTERACTION OF RADIATION WITH MATTER. Progress Report– (1963–1964). (New York Univ., New York). Dec. 1963. Contract AT (30-1)-2962. 16p.

Energy transfer and radical formation in organic compounds are studied with respect to ultraviolet and x-ray radiation. The correlation of efficiencies and lifetimes of solutes in various solvents under conditions of direct solute excitation are studied. The arrangement for measuring fluorescence time constant by the most direct means of using a fast oscilloscope and photomultiplier is now in the final stages of assembly. Ionization energy of organic compounds in liquid and solid form is discussed. Development of x-ray photography and low energy heavy ion accelerator facilities is summarized. (N.W.R.)

**6851** (CEA-tr-R-1534) PREPARATION DE COMPOSES DES ISOTOPES DU $^{36}Cl$ ET $^{82}Br$ DE HAUTE ACTIVITE SPECIFIQUE, PAR LA METHODE DES NOYAUX DE RECUL SOUS DES FLUX NEUTRONIQUES INTENSES. (Preparation of Compounds of Isotopes of $Cl^{36}$ and $Br^{82}$ of High Specific Activity by the Method of Nuclear Recoil under Intense Neutron Flux). L. M. Kourtchatova and B. V. Kourtchaov. Translated into French from report RICC/325. [1962]. 16p.

Activated carbon containing adsorbed Cl or Br is irradiated in a high-intensity neutron beam, and $Cl^{36}$, $Cl^{38}$, and $Br^{82}$ are formed thereby. Post-irradiation washing of the carbon removes the $Cl^{36}$, $Cl^{38}$, and $Br^{82}$ nuclei and allows high specific activities (about 10 mC/mg for $Br^{82}$ and 0.23 mC/mg for $Cl^{36}$) to be obtained. (T.F.H.)

**6852** ON THE RADIATION EFFECTS ON DIPHOSPHOPYRIDINE NUCLEOTIDE. I. INDIRECT RADIATION EFFECTS. Heinz Kuehn (Max-Planck-Institut für Biophysik, Frankfurt am Main). Biophysik, 1: 189-97(1963). (In German)

The effects of x radiation on diphosphopyridine nucleotide (DPN), reduced diphosphopyridine nucleotide (DPN–H), adenine, and nicotinic amide in aqueous oxygen-free solutions were measured by the change in the uv absorption spectra and by the change in the DPN–H fluorescence. The indirect radiation effects on DPN–H were chiefly oxidation to DPN. The radiochemical decomposition of DPN was in part analogous to the influence of alkalis on DPN. (tr-auth)

**6853** NEW TECHNIQUES FOR RADIATION VULCANIZATION. J. V. Bennett (Atomic Energy Research Establishment, Harwell, Berks, Eng.), I. G. Mills, and R. W. Pearson. Ind. Chemist, 39: 469-74(Sept. 1963).

The use of reducing agents to increase the yield of active radicals and crosslinks in the radiovulcanization was investigated. The technique was applied to styrene-butadiene rubber. The effects of impurities, temperature, and carbon black grade are also discussed. The results showed that substantial reductions in the vulcanization dose are possible, and that satisfactory physical properties can be obtained by compounding with reducing agents. The compounding methods are simple, and the addition of antioxidants is not necessary because the redox additive acts as an antioxidant. (P.C.H.)

**6854** THE MECHANISM OF THE RADIATION CHEMICAL DEGRADATION OF AMINO ACIDS. IV. RADIOLYSIS OF VALINE IN AQUEOUS OXYGENATED AND OXYGEN-FREE SOLUTIONS. J. Kopoldová, J. Liebster, and A. Babický (Czechoslovak Academy of Sciences, Prague). Intern. J. Appl. Radiation Isotopes, 14: 489-92(Nov. 1963).

The radiolysis of valine, an amino acid with a branched chain, was studied in oxygenated and oxygen-free aqueous solutions with the purpose of elucidating the effect of branching of the C chain on the mechanism of the radiolytic degradation. (P.C.H.)

**6855** THE MECHANISM OF THE RADIATION CHEMICAL DEGRADATION OF AMINO ACIDS. V. RADIOLYSIS OF NORLEUCINE, LEUCINE AND ISOLEUCINE IN AQUEOUS SOLUTION. J. Kopoldová and J. Liebster (Czechoslovak Academy of Sciences, Prague). Intern. J. Appl. Radiation Isotopes, 14: 493-8(Nov. 1963).

Oxygenated and oxygen-free aqueous solutions of norleucine, leucine, and isoleucine were irradiated with $\gamma$ rays. The products of the radiation chemical reactions in both media were determined. On the basis of the results, the radiation chemical degradation pattern of these amino acids was elucidated and the effects of chain length and branching of the C chain discussed. (auth)

**6856** A MOLECULAR CAPSULE FOR THE PRODUCTION OF ARGON-41. J. W. McClain and W. S. Diethorn (Pennsylvania State Univ., University Park). Intern. J. Appl. Radiation Isotopes, 14: 527(Nov. 1963).

Properties of the Ar clathrate were investigated. It was found that a clathrate is a convenient Ar vehicle for the production of radioactive $Ar^{41}$ ($t_1$ = 1.8 hr). Other advantages of the clathrate include Ar immobility, ease of irradiation, superior post-irradiation control of radioactivity, and convenient storage. A few milligrams of the clathrate is essentially a point source of $Ar^{41}$. The production method is described. (P.C.H.)

**6857** A TECHNIQUE FOR MEASURING $C^{14}O_2$ EVOLUTION FROM SEEDS OF LOW MOISTURE CONTENT. R. D. Durbin and C. M. Christensen (Univ. of Minnesota, St. Paul). Intern. J. Appl. Radiation Isotopes, 14: 528(Nov. 1963).

A method is described that makes it possible to compare respiration of the seed with that of storage fungi. The method is described using wheat seeds. (P.C.H.)

**6858** EFFECT OF ADDITIVES ON THE IONIC REACTION MECHANISM IN THE RADIOLYSIS OF METHANE. P. Ausloos, S. G. Lias, and R. Gordon, Jr., (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 39: 3341-8(Dec. 15, 1963).

The reactions of the ions $C_2H_5^+$ and $CH_5^+$ with $C_3D_8$, $C_4D_{10}$, $C_5D_{12}$, as well as the reactions of $C_2D_5^+$ and $CD_5^+$ with $C_3H_8$ are described. It is shown that ethyl ions undergo a hydride transfer reaction with all higher hydrocarbons even though they are present at a concentration of only 0.01%. The scavengers NO and $O_2$ react with ethyl ions effectively, provided the relative concentration of the higher hydrocarbons is less than that of the free radical scavengers. A proton-transfer reaction between $CH_5^+$ and higher hydrocarbons followed by a rapid decomposition of the protonated hydrocarbon into a carbonium ion and a neutral alkane molecule is shown to occur. From the data it can be deduced that at a methane pressure of 48 cm $G(C_2H_5^+) = 0.9 \pm 0.2$ and $G(CH_5^+) = 1.9 \pm 0.2$. It was concluded that in the radiolysis of methane the $C_2H_5^+$ and $CH_5^+$ ions react with the accumulated products or with the added free radical scavengers, thus excluding the neutralization of these two species. (auth)

**6859** EFFECTS OF γ-RADIATION. PART IX. ACTION OF γ-RADIATION ON DEAERATED SOLUTIONS OF DL-MANDELIC ACID. S. A. Barker, J. S. Brimacombe, and D. H. Spence (Univ. of Edgbaston, Birmingham, Eng.). J. Chem. Soc.: 5117-22(Nov. 1963).

The non-volatile products formed by γ irradiation of DL-mandelic acid in 0.1% deaerated, aqueous solution were determined quantitatively by isotope dilution analysis. Benzaldehyde, phenylglyoxylic acid, benzyl alcohol, hydrobenzoin, and carbon dioxide are the major products of irradiation, whereas αβ-diphenyltartaric acid, αβ-diphenyl-DL-glyceric acid, (±)-benzoin, and benzoic acid are formed in lesser amounts. The products can be accounted for by reactions of the ·CPh(OH)·$CO_2H$ radical initially produced. (auth)

**6860** RADIATION-INDUCED DECOMPOSITION OF ION-EXCHANGE RESINS. PART I. ANION-EXCHANGE RESINS. G. R. Hall and M. Streat (Imperial Coll. of Science and Tech., London). J. Chem. Soc.: 5205-11(Nov. 1963).

Aqueous slurries of the anion-exchange resin Deacidite FF in the hydroxide form were irradiated with $Co^{60}$ γ-rays. Severe chemical decomposition was observed at doses of up to 500 Mrad, chiefly by the destruction of strong-base functional groups resulting in the release of water-soluble aliphatic amines. Analytical techniques for the estimation of individual amines in mixtures are described, and quantitative yields of tertiary, secondary, and primary amines, and ammonia are reported. Traces of formaldehyde were detected, but peroxides and nitrites were found to be absent in the aqueous solutions associated with the irradiated resin. Total anion-exchange capacity does not fall as rapidly as strong-base quaternary capacity. It is shown that an increase in weak-base capacity is due to some conversion of quaternary groups into weak-base amine groups, caused by irradiation. Decomposition of the quaternary functional groups appears to proceed by a simple Hofmann degradation. Possible mechanisms for the production of other products are discussed. (auth)

**6861** EFFECTS OF IONIZING RADIATION ON TWO GELATIN FRACTIONS. II. STUDIES ON VISCOSITY, SEDIMENTATION VELOCITY, AND MOLECULAR WEIGHT EFFECTS. Leonard P. Prusak and Bartley J. Sciarrone (Rutgers Univ., Newark, N. J.). J. Pharm. Sci., 52: 546-52(June 1963).

The effects of subdenaturant levels of irradiation on two fractions, F-I and F-II, isolated from commercial pigskin gelatin, were investigated through viscosity and sedimentation studies in 2M potassium thiocyanate solutions. The source of irradiation was a 3-Mev Van de Graaff accelerator. When used as controls, F-I and F-II were found to have intrinsic viscosity values of 0.675 and 0.550, respectively, while their respective average molecular weights were determined to be 173,000 and 86,000. After subjection to variable irradiation dose, the log of intrinsic viscosity values for F-I was directly proportional to the log of absorbed dose while an inverse proportionality occurred with F-II. Determination of Svedberg constants showed a similar pattern prevailed in the respective fractions when observed under sedimentation velocity conditions. Data obtained indicate random coil configuration was substantially undisturbed as radiation was applied, but bond rupture and linkage processes did occur. (auth)

**6862** THE DETERMINATION OF ALPHA PARTICLE MEAN IONIZATION POTENTIAL IN ETHYLENE AND METHANE FOR DIFFERENT RESIDUAL ENERGIES OF THE ALPHA PARTICLES BY MEANS OF A PROPORTIONAL COUNTER. H. Abel and K. Welker (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 6: 543-5(Oct. 1963). (In German)

Measurements of the average ionization energy, w, of α particles with the help of a proportional counter are described. A $Po^{210}$ preparation situated on the point of a platinum wire, which could be displaced inside a lead to the counter tube, so that the absorbed energy (α rest energy) in the counter volume could be changed stepwise. Methane and ethylene served as measuring gases, which flowed through the counter volume after purification. Inside the available α-rest-energy intervals of 5.3 to 1.5 Mev for methane and 5.3 to 0.6 Mev for ethylene, no variations of the w value with energy could be found. As average values $W_{CH_4}$ = (28.7 ± 0.15) ev/ion pair and $W_{C_2H_4}$ = (27.4 ± 0.15) ev/ion pair were obtained. (tr-auth)

**6863** POLYMETHYLMETHACRYLATE-$C^{14}$ STANDARD SOURCES. A. Siemaszko, R. Plejewski, T. Radoszewski, and W. Lada (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Kernenergie, 6: 558-61 (Oct. 1963). (In German)

$C^{14}$-labeled polymethylmethacrylate films were prepared as standard sources. The surfaces amounted to 0.8 and 95 $cm^2$. The β emission lay between $10^3$ and $10^6$ β particles/min at volume angles of 2π. The accuracy of the measurement amounted to ±7%. (tr-auth)

**6864** RADIATION GRAFTING OF VINYL MONOMERS TO POLYOLEFIN FIBERS. U. Zhun-Zhuy, Kh. A. Stasyuk, L. A. Kocherginskaya, N. D. Rozenblyum, A. A. Konkin, and Z. A. Rogovin (Moscow Technical Inst.). Khim. Volokna, No. 5, 12-15(1963).

The results of an experimental investigation on a method for producing grafted polyolefins using pre-radiation to reduce or eliminate formation of homopolymer are presented. A method was developed for the graft polymerization of a series of vinyl monomers to polypropylene fibers subjected to preliminary gamma radiation from $Co^{60}$ in the presence of air. It was found that an increase in radiation of polypropylene and polyethylene fibers raises the content of peroxide groups resulting in a simultaneous reduction in strength and elongation of the fiber. In the presence of a 3-4 fold excess of ferrous sulfate with respect to the peroxide groups, the graft polymerization of acrylic acid and 2-methyl-5-vinylpyridine to previously irradiated polypropylene fiber containing an antioxidant proceeds without formation of the homopolymer. In the graft polymerization of acrylonitrile, the formation of a small quantity of homopolymer is observed. (OTS)

**6865** REDOX CONVERSION OF ACCEPTORS IN ORGANIC SOLVENTS UNDER THE INFLUENCE OF IONIZING RADIATION. I. CONVERSION OF IRON CHLORIDES IN ACETONE SOLUTIONS. M. Roder, N. A. Bakh, and L. T. Bugayenko (Moscow State Univ.). Kinetika i Kataliz, 4: 193-7(Mar.-Apr., 1963).

A study was made on the effects of x rays on acetone solutions of ferrous and ferric chloride. It was established that ferric is reduced, while ferrous is oxidized as a result of interaction with short-lived products resulting from radiolysis of the solvent. It was demonstrated that a stationary state is established with large doses of radiation. It is hypothesized that non-radical type short-lived products of acetone radiolysis are involved in the reduction of ferric. (OTS)

**6866** REDOX CONVERSIONS OF ACCEPTORS IN ORGANIC SOLVENTS UNDER THE INFLUENCE OF IONIZING RADIATION. II. CONVERSION OF COPPER COMPOUNDS IN ACETONE SOLUTIONS. M. Roder, N. A. Bakh,

and L. T. Bugayenko (Moscow State Univ.). Kinetika i Kataliz, 4: 353-6(May-June 1963).

A study was made of the action of x rays on solutions of cuprous and cupric chloride. It was established that in the absence of oxygen, cupric is reduced to cuprous with a yield of 17.3 ions per electron volt. Oxidation of cuprous does not take place. In the presence of oxygen, cuprous is oxidized to cupric with high yields. (OTS)

**6867** FOUR TRENDS OF NUCLEAR CHEMISTRY. Lavrukhina. Komsomol'skoe Znamya, p.4(Oct. 10, 1963).

Four basic trends in the development of nuclear chemistry are discussed. The main, classical trend is the application of chemical methods to study nuclear changes. This includes the synthesis of new elements, such as the new isotope of the 102nd element discovered at Dubne. Synthetic elements, for use in industry, may be produced in quantity in nuclear reactors. A second trend is nuclear chemistry of outer space. By studying isotopes in meteors, it is possible to learn about the distribution of cosmic rays in space. A third trend is the study of the origin of chemical elements. On the assumption that all elements originated from various nuclear conversions, it remains to find those heavenly bodies where such conversions are now taking place. This would presumably shed light on methods for the synthesis of rare metals, which are now finding greater uses. The fourth trend is the preparation of substances with preassigned properties. If a semiconductor is required, for example, consisting of germanium alloyed with some other element, a germanium crystal is irradiated with neutrons. This causes nuclear changes to take place in the crystal resulting in a semiconductor with traces of a new element with better properties. The relation between nuclear chemistry and radiation chemistry and the so-called nuclear welding of polymers to metals is also discussed. (OTS)

**6868** OXIDATION OF n-BUTANOL IN THE LIQUID PHASE, INITIATED BY GAMMA-IRRADIATION FROM $Co^{60}$. P. N. Komarov, E. V. Barelko, and M. A. Proskurnin (Karpov Inst. of Physics and Chemistry, Moscow). Neftekhimiya, 3: 609-14(July-Aug. 1963).

A study was made of the liquid phase oxidation of n-butanol initiated by gamma-irradiation from a $Co^{60}$ source. It was found that irradiation causes a shortening in the induction period. A study was made of the change in concentration of reaction products during the initial stage and the effect of adding them on the speed of the process. It was established that peroxide compounds are responsible for the branching and not aldehydes. It was observed that the induction period depends very little on the intensity of the radiation dose, while the rate of peroxide formation and the maximum concentration of the latter drop with increasing temperature. These phenomena were qualitatively correlated with the chain theory of oxidation. Evaluation of the formal significance of the activation energy of the branching process showed it to be very low. Discontinuation of irradiation at a certain stage of the reaction causes a marked increase in the yield of incomplete oxidation products. (OTS)

**6869** A VAPOR-PHASE TECHNIQUE FOR RADIATION-INDUCED GRAFTING OF VINYL MONOMERS TO FIBERS. Arthur A. Armstrong, Jr. and Henry A. Rutherford (North Carolina State Coll., Raleigh). Textile Res. J., 23: 264-73(Apr. 1963).

A technique for the radiation grafting of volatile vinyl monomers to fiber substrates is described. The monomer is applied from the vapor phase while the samples are exposed to gamma radiation from $Co^{60}$. The fibrous materials that are relatively unstable toward radiation are the ones that add the vinyl compounds the most readily. These are the cellulosics (cotton and rayon), cellulose esters (acetate), polyamides (nylon 66), and polypropylene fibers. The polyesters and the acrylics show little tendency to undergo graft polymerization. The monomers that were studied are methyl acrylate, ethyl acrylate, acrylonitrile, butadiene, vinyl acetate, methyl methacrylate, vinyl chloride, styrene, ethylene, propylene, and divinyl sulfone. The most successful experiments were conducted with the first five of the monomers, and acetate and polypropylene fibers take part in the grafting process most readily. The rate of grafting of the monomers to many of the substrates can be materially increased by the addition of a third material to the system. Water, methanol, and acetic acid vapors accelerate the rate of grafting to cotton, rayon, and nylon. The modification of cotton by the radiation addition of acrylonitrile results in a fiber almost completely resistant to microorganisms. This effect can be achieved by the deposition of only 3.5% of the monomer (as polymer), and the fiber retains the appearance and feel of untreated cotton. The product is superior in these respects to that made by the addition of acrylonitrile from the iron-peroxide catalyst system. (auth)

**6870** ELECTRON IMPACT STUDIES OF SOME SULPHIDES AND DISULPHIDES. B. G. Gowenlock, J. Kay, and J. R. Majer (Univ. of Birmingham, Eng.). Trans. Faraday Soc., 59: 2463-8(Nov. 1963).

The appearance potentials of a number of radical ions produced on electron impact of organic sulfur compounds have been measured. In order to elucidate the rearrangement processes of the $(CH_3)_2S^+$ ion, a half-deuterated dimethyl sulfide has been synthesized and the appearance potentials and mass spectra studied. The significance of the measurements for bond-dissociation energy relationships in organic S compounds is discussed. (auth)

**6871** CHEMICAL CONSEQUENCES OF NUCLEAR ACTIVATION IN SOLIDS. PART 2. EFFECTS OF THE $^{35}Cl(n,\alpha)^{32}P$ REACTION IN POTASSIUM CHLORIDE CRYSTALS. J. S. Butterworth and I. G. Campbell (Univ. of Manchester, Eng.). Trans. Faraday Soc., 59: 2618-24(Nov. 1963).

The oxidation states of $P^{32}$ species recoiling from the $Cl^{35}(n,\alpha)P^{32}$ reaction in KCl lattices have been studied as a function of the gamma doses received by the crystal prior to and during neutron irradiation, and as a function of thermal annealing at various temperatures. In addition to the oxidative thermal annealing processes usually found for recoils from nuclear reactions in solids, reducing reaction can occur. These last seem to have a complex temperature dependence. Gamma irradiation prior to neutron bombardment provides a reducing environment in the crystal, although this effect tends to be destroyed at higher doses. Evidence is presented to suggest that F-centers may be the agents responsible for the reducing reactions. (auth)

**6872** CHEMICAL EFFECTS OF THERMAL NEUTRON CAPTURE. ANNEALING BY COMPRESSION IN NEUTRON IRRADIATED CRYSTALS. T. Andersen (Univ. of Aarhus, Denmark). Trans. Faraday Soc., 59: 2625-33(Nov. 1963).

A study of the annealing of recoil damage in ammonium dihydrogen phosphate by compression has been carried out using chemical and paper electrophoretic separation of the products. By studying the effect of various combinations of compression, thermal, and radiation annealing a complete picture of the effect of compression has been established. The results indicate that the strain created and the defects

generated by the compression contribute to the changes in retention. (auth)

**6873** CHEMICAL CHANGES IN $\beta$ DECAY PROCESSES. V. D. Nefedov, V. M. Zaitsev, and M. A. Toropova (Leningrad State Univ.). Usp. Khim., 32: 1367-96(Nov. 1963). (In Russian)

Nuclear-physical factors contributing to the state of daughter nuclei during $\beta$ decay, processes developing in nuclear systems, and experimental methods used for studying chemical changes during $\beta$ decay are analyzed and reviewed. (125 references) (R.V.J.)

**6874** NUCLEAR CHEMISTRY AND ITS APPLICATIONS. M. Haissinsky. Translated by D. G. Tuck from "La Chimie Nucleaire et ses Applications." ADIWES International Series in Chemistry. Reading, Massachusetts, Addison-Wesley Publishing Co., Inc., 1964. 847p.

A comprehensive survey of the domain of nuclear chemistry (including radiochemistry and radiation chemistry) and its numerous applications is presented. Information is included on: nuclear chemistry and nuclear physics; physical chemistry; applications of natural and artificial tracers; and radiation chemistry and radiation physics. Considerable attention is given to chemical separation procedures and techniques. Problems from the various chapters and a table of the nuclides are appended. (P.C.H.)

**6875** IMPROVEMENTS IN OR RELATING TO CELLULOSIC TEXTILE MATERIALS. (to Heberlein and Co., AG). British Patent 941,689. Nov. 13, 1963. Priority date Jan. 23, 1961, Switzerland.

A process is given for treating a cellulosic textile material to obtain improvement in the wet and dry crease resistance and in some cases even the fiber strength of the material. The process comprises treating the material with a small proportion of a sensitizer, irradiating the treated material at low doses, and finally reacting the activated material with a graftable chemical. The sensitizer may be an unsaturated organic compound, an aromatic compound, or an amine. Several examples of the process are given using cotton poplin fabric as the material, 1,4-diphenylbenzene as the sensitizer, and acrylamide, divinyl sulfone, nonyl alcohol, and a glycol polyacetal as the graftable chemical. (D.L.C.)

**6876** PROCESS FOR THE PREPARATION OF POLYMERS OF UNSATURATED ALDEHYDES BY RADIATION. (to Shell Internationale Research Maatschappij N. V.). British Patent 944,359. Dec. 11, 1963. Priority date Oct. 21, 1960, United States.

A process is given for producing solid high-molecular-weight polymers or copolymers of ethylenically unsaturated aldehydes. The method consists of exposing the aldehyde to high-energy ionizing radiation in an acidic aqueous medium. The medium comprises between 0.001 and 2% acid and is of a pH 1 to 5, and the aldehyde may be acrolein or a substituted acrolein and may be copolymerized with other unsaturated monomers. Several examples of the process are given using acrolein and methacrolein. (D.L.C.)

**6877** PROCESS FOR POLYMERIZING UNSATURATED MONOMERS USING HIGH ENERGY IONIZING RADIATION. (to Shell Internationale Research Maatschappij N.V.) British Patent 945,701. Jan. 8, 1964. Priority date June 6, 1960, United States.

A method for polymerizing ethylenically unsaturated monomers, such as isobutylene and $\alpha$-methyl styrene, using high-energy ionizing radiation is described. The process consists of exposing the monomer to the radiation in the presence of finely divided solid particles of certain metal halides, hydroxides, or oxides. Several examples are given. (M.C.G.)

**6878** IRRADIATED CHEMICAL REACTIONS. (to Continental Oil Co.). British Patent 946,050. Jan. 8, 1964. Priority date Nov. 27, 1959, United States.

A process for preparing fluoride compounds without the use of inorganic and organic catalysts is described. At least one organic fluoride compound is reacted with at least one nonfluorinated olefinically or acetylenically unsaturated organic compound with a molecular weight below 1000 at a pressure less than 1000 psig in the presence of gamma radiation. The solid reaction product is recovered. Ten examples are given. It was provided that when the organic fluoride compound is trifluorochloroethylene the nonfluorinated compound is not a monomer having the general formula $H_2C = CR_1R_2$ where $R_1$ represents H or $CH_3$ and $R_2$ represents $CH_3$, Cl, $OC = OCH_3$, $COOCH_3$, or $COOC_2H_5$, and that when the unsaturated organic compound is ethylene the fluoride compound is not a fluorinated methane containing one or more chlorine, bromine, or iodine atoms. (M.C.G.)

**6879** METHODS OF PRODUCING IODINE-131. Michel Douis and Umberto Rosa (to Commissariat à l'Energie Atomique). U. S. Patent 3,114,608. Dec. 17, 1963. Priority date Apr. 15, 1960, France.

A method of producing $I^{131}$ by neutron irradiation of tellurous anhydride is patented. The irradiated anhydride is dissolved in sodium hydroxide to form an alkaline tellurite solution. The solution is concentrated, and the tellurite is changed into tellurate by oxidizing the solution with hydrogen peroxide in the presence of an oxidation catalyst, such as an alkali metal molybdate or an alkali metal vanadate. The solution is then acidified and distilled to recover the iodine. The method may be performed in the presence of an inert gas, such as N. (M.P.G.)

**6880** IRRADIATION OF FLUOROCARBON COPOLYMERS. George Henry Bowers, III (to E. I. du Pont de Nemours and Co.). U. S. Patent 3,116,226. Dec. 31, 1963. Filed Mar. 16, 1959.

A process is given for producing crosslinked fluorocarbon polymers having improved mechanical properties at high temperatures. The process comprises irradiating a fluorocarbon copolymer at a temperature above the glassy state transition temperature but below the thermal decomposition temperature of the copolymer. The copolymer is a copolymer of tetrafluoroethylene and an unsaturated fluoroolefin having the general formula $CF_2 = CXC_nF_{2n}Y$ or $CF = CF - (CF_2)_{n+1}$, where X is F or perfluoroalkyl radical, Y is F or H, and n is an integer from 1 to 10. (D.L.C.)

## Separation Processes and Procedures

**6881** (BM-RI-6346) RADIOACTIVITY IN ALKALINE LEACH MILLING PROCESSES. Kenneth E. Tame (Bureau of Mines. Salt Lake City Metallurgy Research Center). May 1963. 10p.

A laboratory investigation was made to study radioactive waste disposal problems in carbonate leaching mills. The laboratory procedure consisted of leaching the ground ore at 85 to 90°C and 50% solids for 6 hours in a sodium carbonate–sodium bicarbonate solution. The pulp was filtered to obtain a pregnant solution that was reacted with sodium

hydroxide to precipitate the uranium as sodium diuranate. Regeneration of the barren solution was accomplished by gassing with carbon dioxide. The solution then was reused by advancing the solution through the washing to the leaching operations. The radioactivity in the pregnant solution was unusually high, averaging 6,500 disintegrations per minute of radium-226 per liter. However, over 95% of the radium was precipitated with the uranium. Consequently, no buildup of radium occurred upon reuse of the barren solutions for washing. (auth)

**6882** (BNL-7572) THE VOLATILE CHARACTERISTICS OF SEVERAL NITROSYL FLUORIDE SALTS. F. L. Horn (Brookhaven National Lab., Upton, N. Y.). July 15, 1963. Contract AT-30-2-GEN-16. 16p. (CONF-184-3)

From Symposium on Inorganic Fluorine Chemistry, Argonne, Ill., Sept. 1963.

Results are reported of volatility studies using NOF gas and various uranium salts. The conditions of uranium volatilization were explored, and possible mechanisms of volatile transfer of uranium are discussed. The separation of uranium from Zr, fission products, and Pu by NOF volatilization in the Nitrofluor process is considered in detail. (D.L.C.)

**6883** (HW-SA-3211) SOLVENT EXTRACTION PROCESSES FOR RECOVERY OF RADIOACTIVE MATERIALS. G. L. Richardson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 18, 1963. Contract AT(45-1)-1350. 15p. (CONF-196-1)

From American Institute of Chemical Engineers Northwest Regional Meeting, Portland, Oreg., Oct. 1963.

Four solvent extraction processes were developed for separating fission products from stored waste solutions: D2EHPA, DPA, BAMBP, and CSREX. The chemistry, flowsheets, and pilot plant performance of these processes are described briefly, and the pH dependency of the separations is pointed out. Either the D2EHPA or CSREX process will be used to process current and stored radioactive wastes for the Waste Management Program. (D.L.C.)

**6884** (NP-13412) MONTHLY REPORT [OF] DEVELOPMENT [ON FEED MATERIALS], OCTOBER 1963. (Eldorado Mining and Refining Ltd. Research and Development Div., Port Hope, Ont.). 7p.

Vanadium recovery tests were made on Beaverlodge ore and tailings to study the effect of retention time, flash calcination, and sodium carbonate addition in roasting on the carbonate leach extraction. A calibration curve is given for an oxygen analyzer for monitoring the oxygen content of Beaverlodge carbonate leach liquors. The status of equipment at Port Hope is described briefly. Results are presented of metallographic examinations of defects in extruded 9.8 U–Al billets and of carbide particles in U–2% Mo alloys. (D.L.C.)

**6885** (ORNL-TM-752) RESULTS OF VOLATILITY PILOT PLANT COLD URANIUM FLOWSHEET DEMONSTRATION RUN TU-1. E. C. Moncrief (Oak Ridge National Lab., Tenn.). Jan. 9, 1964. Contract W-7405-eng-26. 20p.

A two-element dissolution of 50.89 kg of Zr–U alloy fuel element with 92 g/min of anhydrous HF in NaF–LiF–$ZrF_4$ fused salt at 490 to 670°C was made with the fuel element 113% submerged. Initial and final $ZrF_4$ contents in the equimolar NaF–LiF fused salt were 25.1 and 40.3 mole %, respectively. Fluorination of the dissolver salt was accomplished with 12 SLM fluorine flow at 500 to 505°C. The sorption-desorption cycle of $UF_6$ on NaF was accomplished at 100 and 100 to 400°C, respectively, in two fixed-bed absorbers. Product $UF_6$ was collected in a cold trap. A complete uranium material balance over the run was not made. However, nonrecoverable uranium losses for the run were only 0.362 g. Product impurity level was <1421 ppm total cations based on $UF_6$ with Na at 1300 ppm being the major impurity. A fuel dissolution rate of 2.52 kg/hr was obtained with an over-all HF utilization of 35.2%. Fluorine utilization was 5.7% for 99.90% conversion of the $UF_4$ to $UF_6$. Final salt U content was 1.2 ppm. Fluoride salt recovery was 100.5%. The generation of ~300 g of off-gas solids occurred during dissolution. (auth)

**6886** (UCRL-10928) LONGITUDINAL DISPERSION IN PACKED EXTRACTION COLUMNS WITH AND WITHOUT PULSATION. Joon S. Moon, Alphonse Hennico, and Theodore Vermeulen (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley). Oct. 23, 1963. Contract W-7405-eng-48. 125p.

Single-phase Péclet numbers were measured by an unsteady-state step-input method. For pulsed columns, the use of pulsation serves to decrease the Péclet numbers as the amplitude increases, and to a lesser extent as the frequency increases. The effect is somewhat more pronounced in beds of Raschig rings and Berl saddles than in beds of uniform spheres. The Péclet-number decrease diminishes with increasing fluid viscosity and also with increasing flow rate; the results indicate a rise in Péclet number for viscous fluids. For unpulsed columns, Péclet numbers in the low-Reynolds-number regime down to a Reynolds number of 0.04 were obtained, using 0.0058-in.-diameter glass beads as a packing material. The modified Péclet number P remained constant at 0.205 ± 0.020. Péclet numbers for counterflowing liquid-liquid systems were measured for both continuous and dispersed phases, with the behavior of the latter depending upon whether it does or does not wet the packing material. For both pulsed and unpulsed columns, the axial Péclet number of one phase decreases as the flowrate of the other phase increases. The effect is much greater for the continuous than for the dispersed phase, and also for the dispersed-phase wetting rather than nonwetting. A correlation was developed for dispersed-phase Péclet number without pulsation, which includes the physical properties for the dispersed phase. The measurement of both dispersed- and continuous-phase concentration profiles was undertaken to determine the applicability of the Miyauchi model to steady-state mass transfer, using the Péclet numbers obtained from unsteady-state conditions. Experimental profiles inside the packed bed were compared with the theoretical profiles, and the agreement between these two profiles was quite satisfactory. It is concluded that the one-dimensional diffusion model adequately represents the fluid behavior in packed-bed extraction columns with and without pulsation. With appropriate Péclet numbers for both phases, this model should be very useful for accurate and economical design of packed columns. The Péclet numbers determined by the unsteady-state tracer-injection method appear to represent closely the longitudinal-dispersion behavior during steady-state extraction. (auth)

**6887** (AEC-tr-6166) CAPITAL AND OPERATING COSTS OF PLANTS FOR THE REPROCESSING OF IRRADIATED NATURAL URANIUM. L. Thiriet, C. Jouannaud, J. Couture, J. DuBoz, and C. Oger. Translated for Oak Ridge National Lab., Tenn., from Paper Presented at the Meeting of the European Society of Atomic Energy on "Fuel Cycles for Power Reactors," Baden-Baden, Sept. 1963. 15p.

A general method is presented for analyzing the costs of plants for reprocessing of irradiated fuels. The method classifies the costs by the principal factors of production

and proceeds to a detailed analysis of investments and operating costs, followed by regroupings which permit working out simplified and synthetic models. The case of single-purpose plants reprocessing natural U is examined, and a comparison is given of the cost structures of 3 ton/day reprocessing plants in U.S. and France. (D.L.C.)

**6888** (EURAEC-837) USE OF TRILAURYLAMINE IN THE EXTRACTION OF PLUTONIUM FROM NUCLEAR FUELS. Special Report No. 17. G. Valentini, L. Taglioni, and N. Mostin (Brussels. Centre d'Étude de l'Energie Nucléaire and Société Belge pour l'Industrie Nucléaire, Brussels). [nd]. Work Performed under United States–Euratom Joint Research and Development Program. Contract 027-60-7 RDB. 35p. (A translation of BN-6307-04).

The first part of the present report is devoted to the determination of the plutonium distribution coefficients in nitric solutions (with and without uranium) in an organic phase consisting of trilaurylamine diluted in Solvesso 100, in presence of nonyl alcohol. The second part describes the application of the obtained data to the separation of plutonium from uranium in mixer settlers. Finally, a numerical example illustrates the applicability of this procedure to the recovery of plutonium. (auth)

**6889** SEPARATION OF ZIRCONIUM-95 AND NIOBIUM-95 BY SOLVENT EXTRACTION USING ACETYLACETONE. Tsunenobu Shigematsu, Masayuki Tabushi, and Masakazu Matsui. Bull. Inst. Chem. Res., Kyoto Univ., 41: 212-18(July 1963).

The separation of $Zr^{95}$ and $Nb^{95}$ by solvent extraction was studied using acetylacetone as a chelating agent. Zirconium acetylacetonate was almost quantitatively extracted with benzene at pH 5 ~ 7, whereas Nb was not extracted. Under the optimum condition the extraction recovery of $Zr^{95}$ was 97% or more, and the decontamination factor for $Nb^{95}$ was $3 \times 10^2 \sim 1 \times 10^3$. The extraction procedure would be convenient for the preparation of $Zr^{95}$ tracer solution, because Zr can be easily back-extracted into 0.2N sulfuric acid solution. (auth)

**6890** ON THE EXTRACTION OF FISSION PRODUCTS WITH MONO- AND DIBUTYL PHOSPHATES. V. B. Shevchenko and V. S. Smelov. Ekstraktsiya, Teoriya, Primenenie, Apparatura, Sb. Statei 1962, 257-63(1962).

The extraction of $Zr^{95}$, $Nb^{95}$, $Ce^{144}$, $Cs^{137}$, $Sr^{90}$, $I^{131}$, and $Ru^{106}$ with a 20% solution of tributyl phosphate (I) in hydrogenated kerosene, containing various concentrations of monobutylphosphoric (II) and dibutylphosphoric (III) acids, as well as solutions of II and III in benzene, was investigated. The concentrations of the elements to be extracted comprised $10^{-1}$–$^{10}$M. It was established that II and III have practically no influence on the extraction of Ce, Cs, Sr, I, and Ru with a 20% solution of I. The extraction of Zr and Nb with 20% I increases sharply, beginning with concentrations of II and III of 0.001M. In the extraction of Zr and Nb with solutions of II and III in $C_6H_6$, the slope of the straight lines log D – log [NK], where [NK] is the equilibrium concentration of II or III, while D is the distribution coefficient, is equal to ~1 for Zr and ~2 for Nb. The slope of the curve log D – log $[H^+]$ is equal to –1 for Zr and +1 for Nb. A change in the concentration of $NO_3^-$ ions has practically no influence on the extraction of Zr and Nb with solutions of II or III. The hypothesis that extraction with solutions of II and III proceeds according to the equations $ZrK_3^+ + HK \rightleftharpoons ZrK_4 + H^+$ and $Nb(OH)_3K_3^- + 2HK + H^+ \rightleftharpoons NbK_5 + 3H_2O$ is in agreement with the observed patterns. Here HK denotes II or III, considered as monobasic acids. The equilibrium constants corresponding to the equations cited are equal to $(0.88 \pm 0.04) \times 10^2$ for Zr-II, $(3.9 \pm 0.4) \times 10^2$ for Zr-III, $(0.97 \pm 0.06) \times 10^2$ for Nb-II, and $(2.85 \pm 0.15) \times 10^2$ for Nb-II. (Referativnyy Zhurnal, Khimiya, No. 16, Aug. 1963)

**6891** DECONTAMINATION OF THORIUM. DIRECT PRECIPITATION OF THORIUM SULFATE FROM THORIUM NITRATE SOLUTIONS IN TRIBUTYL PHOSPHATE. K. J. Bril and P. G. de Saboia Araujo (Research Laboratory, Orquima S.A., Sao Paulo, Brazil). Ind. Eng. Chem., Process Design Develop., 3: 8-10(Jan. 1964).

Direct precipitation of thorium sulfate from thorium nitrate solution in 46 vol % TBP-Varsol mixtures by means of dilute sulfuric acid allows exceptionally high decontamination of thorium for uranium. Decontamination factors are reported for $BO_3^{3-}$, $Cu^{2+}$, $Cr^{3+}$, $MoO_4^{2-}$, $K^+$, $Ni^{2+}$, $Cd^{2+}$, $Co^{2+}$, $Zn^{2+}$, $Ti^{4+}$, $Ca^{2+}$, $Na^+$, $Fe^{3+}$, $Zr^{4+}$, and $PO_4^{3-}$. (auth)

**6892** ON THE STUDY OF CO-PRECIPITATION OF THORIUM AND RARE EARTHS WITH CALCIUM SULPHATE ON A TRACER SCALE. B. C. Purkayastha and S. N. Bhattacharyya (Sara Inst. of Nuclear Physics, Calcutta). J. Indian Chem. Soc., 40: 759-68(Sept. 1963).

Coprecipitation of thorium ($Th^{234}$) and rare earths ($Ce^{144}$, $Pm^{147}$, $Eu^{152}$, $Eu^{154}$, and $Y^{91}$) with calcium sulfate was investigated. Thorium and rare-earth tracers were taken up through mixed crystal formation by an unstable form of calcium sulfate that subsequently changes to stable monoclinic gypsum. The range of mixed crystal formation in all these cases was, however, very narrow. When the concentration of the tracer ion exceeded that range, the uptake obeyed an adsorption isotherm. It was found that the presence of one rare earth, the concentration of which is just beyond the range of mixed crystal formation, causes the uptake of another rare earth (in tracer concentration) to obey the Freundlich adsorption isotherm. Uptake of yttrium and thorium, however, differs in this respect from that of rare earths. These two in finite quantity do not exert any influence on the uptake of tracer rare earths and vice versa. A comparative study of the λ values for different rare earths indicated that mixed crystal formation in these cases is through double-salt formation. (auth)

**6893** OPTIMAL TESTING OF MULTI-STAGE COUNTERCURRENT LIQUID-LIQUID-EXTRACTION COLUMNS. R. Kiessling (Institut für Physikalische Stofftrennung, Leipzig). Kernenergie, 6: 540-3(Oct. 1963). (In German)

With the help of a graphical method, curves for the dependence of the relative error in the determination of the number of stages of the extraction factor, of the relative degree of extraction, and of the error in the determination of both these quantities for the testing of a liquid-liquid countercurrent extraction column were obtained. The existence of an optimal extraction factor for testing with maximum accuracy was discovered and established so that the testing of a column by countercurrent extraction with continuous addition of material in one column end would be more incorrect the more stages the column contained. (tr-auth)

**6894** SOLVENT EXTRACTION CHEMISTRY SYMPOSIUM. PART III. RECOVERY AND PURIFICATION OF PLUTONIUM BY TRILAURYLAMINE EXTRACTION. A. Chesne, G. Koehly, and A. Bathellier (Commissariat a l'Energie Atomique, Fontenay-aux-Roses, France). Nucl. Sci. Eng., 17: 557-65(Dec. 1963).

Trilaurylamine nitrate diluted in dodecane is considered as an extracting agent for plutonium. The use of this solvent is proposed for a tail-end plutonium recovery from irradiated uranium solutions that have already been purified by one or more TBP cycles. Mention is made of general properties of the solvent. The study of the stripping

of plutonium is emphasized. The first choice stripping solution is a mixture of sulfuric and nitric acid that gives a final concentrated and purified $Pu^{4+}$ solution. Some alternative purification flowsheets are given. They show that a decontamination factor of $10^4$ can be attained for Nb–Zr and uranium. Kinetics of the extraction and radiolytic degradation of the solvent are discussed. (auth)

**6895** EXTRACTION OF SODIUM AND CESIUM POLYIODIDES INTO NITROBENZENE. Louis M. Slater (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 17: 576-85(Dec. 1963).

Cesium ($<5 \times 10^{-3}$M) can be extracted from aqueous sodium iodide solutions into equal volumes of 0.2M $I_2$ in nitrobenzene at 25°C with extraction coefficients as great as two thousand. Cesium may be back-extracted by equilibration with ~4M or stronger nitric acid. The separation factor of cesium (~$10^{-7}$M) from sodium in extractions made from sodium iodide solutions into equal volumes of 0.2M $I_2$ in nitrobenzene at 25°C remained fairly constant at ~1500 up to ~1M NaI. It decreased to ~100 at 8M NaI. At this point the cesium extraction coefficient was still greater than two. The decrease in the separation factor is seen as largely due to the decrease in the ratio of the activity coefficient of the cesium ion to that of the sodium ion in the aqueous phase. Extraction data for sodium and cesium from various solutions and under a variety of conditions are given. Sodium and cesium ions are seen extracted as ion association compounds with triiodide ions. Polyiodide ions as complex as the enneaiodide are formed subsequently in the organic phase. Sodium and cesium polyiodides are thought to be essentially ionized in nitrobenzene. Extractions are believed to be the result of the "squeezing out" from aqueous solution into nitrobenzene of ion pairs of cations of small ionic potential together with large anions that are compatible with the organic solvent. The driving force behind the extractions comes largely from the reformation of the hydrogen bonded water structure in the relatively large cavities left by the extracted ion pairs. (auth)

**6896** PUREX PROCESS PERFORMANCE VERSUS SOLVENT EXPOSURE AND TREATMENT. Donald A. Orth and Thomas W. Olcott (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. Sci. Eng., 17: 593-612(Dec. 1963).

An analysis of the Savannah River Plant (SRP) operation for reactor fuel reprocessing is given. The variables in operation and two different mixer-settler installations with widely varying contactor size and residence time of the solvent are discussed. The time covered includes two diluents; Ultrasene and Adakane. The principal of the equilibrium model of solvent is discussed. The influence of solvent quality of SRP performance and the changes with changing diluents are discussed. 34 references. (R.E.U.)

**6897** TBP DECOMPOSITION PRODUCT BEHAVIOR IN POST-EXTRACTIVE OPERATIONS. H. T. Hahn and E. M. Vander Wall (Phillips Petroleum Co., Idaho Falls, Idaho). Nucl. Sci. Eng., 17: 613-19(Dec. 1963).

The behavior was studied of dibutyl phosphoric acid (HDBP) and its complexes in the uranium stripping and TBP scrubbing operations. The solubilizing effect of TBP upon $UO_2(DBP)_2$ is shown. At low concentrations of nitric acid and TBP, $UO_2(DBP)_2$ has greater solubility in the aqueous phase. For enriched uranium stripping conditions, the solubility ratio is almost unity, and DBP may partially accompany uranium through the stripping step. The partition of uranium between TBP-Amsco and dilute nitric acid solutions is shown as a function of both HDBP and TBP concentrations. In the region of interest, uranium appears to be extracted as a complex with DBP/U ratio of one. As the DBP/U ratio increases from one to two, solid $UO_2(DBP)_2$ appears. Above a ratio of two, and in the presence of TBP, no solids remained after equilibration, indicating additional DBP-TBP complex formation. For the succeeding TBP scrubbing operation, the TBP distribution coefficient between Amsco and aqueous phase is 290. However, pilot plant experiments were unsuccessful in scrubbing to the desired phosphate level due to two effects. Laboratory studies indicated an equilibration time of two minutes, considerably longer than permitted in the pilot plant tests. The presence of an aqueous-favoring phosphorous species was also established. The latter can be removed by absorption on a hydrated zirconium oxide column and the column regenerated with NaOH. The absorption behavior of HDBP and a plant evaporator phosphate contaminant are compared. (auth)

**6898** PERFORMANCE AND DEGRADATION OF DILUENTS FOR TBP AND THE CLEANUP OF DEGRADED SOLVENTS. E. S. Lane (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Sci. Eng., 17: 620-5(Dec. 1963).

Research work at AERE is reviewed under the following headings: chemistry of diluent degradation; methods for the cleanup and disposal of degraded TBP-hydrocarbon solvents; and treatments to improve kerosene as a diluent and comparisons of alternative diluents. The performance of diluents was rationalized on the basis of their composition (determined by vapor-phase chromatography), reaction with nitrous acid, and the subsequent reactions of nitroparaffins with acids and alkalies. There is evidence that the species responsible for the retention of zirconium in degraded solvents are hydroxamic acids (Alkyl-CONHOH) and their formation from nitroparaffins is outlined. Nitroparaffins readily form salts with alkanolamines and a complete removal of complexing agents from degraded solvent was possible on this basis by extraction with certain alkanolamines which are insoluble in TBP-kerosene. Alkaline hydrogen peroxide shows promise for the removal of firmly bound uranium in solvents. Chemical methods are outlined for the separation of TBP from its diluents as a preliminary step towards disposal or recovery of badly degraded solvent. Pretreatment processes for improving kerosene, and a new class of stable diluents, the conjunct polymers of simple olefins, are described. (auth)

**6899** PROPERTIES OF DEGRADED TBP-AMSCO SOLUTIONS AND ALTERNATIVE EXTRACTANT-DILUENT SYSTEM. C. A. Blake, Jr., W. Davis, Jr., and J. M. Schmitt (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 17: 626-37(Dec. 1963).

The formation and chemical properties of the major degradation products of several diluents in contact with acidic nitrate solutions were studied, together with (1) methods for purifying degraded solvent, (2) methods of pretreating the solvent to minimize degradation, and (3) the relative stability of several solvent systems. Emphasis was on Amsco 125-82, a specially treated naphtha used extensively at ORNL in radiochemical processing. Degradation of the diluent, usually containing 1M TBP, was induced by boiling with $HNO_3$ or by irradiating ($Co^{60}\gamma$) while agitating the solvent phase with $HNO_3$. Nitroparaffins, $RNO_2$, were the major degradation products and were formed at twice the rate when TBP was present during degradation. Under the conditions of degradation 100 watt-hr/liter exposure was essentially equivalent to 11 hr boiling with 2M $HNO_3$ as shown by Zr–Nb extraction, total organic nitrogen

analysis, and spectrophotometric analysis. Extraction from acid solution of certain fission products, e.g., Zr–Nb but not Ru, increased markedly after the degraded solvent was treated with alkaline reagents, and a test employing solid calcium hydroxide was developed to estimate the extent of diluent degradation. The alkaline treatment converted a significant fraction of the nitroparaffin to the enol form. There was synergistic extraction of Zr–Nb by the combination of TBP and degraded diluent. Cleanup of the degraded solvents can be attained by scrubbing with alkanolamines to remove nitroparaffin-amine salts or by contacting with activated alumina. Both methods have doubtful economy and the latter requires solids handling. Low pressure flash distillation is an effective, inexpensive method for partial or total repurification of degraded TBP-Amsco. With aliphatic diluents the configuration most stable against nitration is the simplest, e.g., n-dodecane. Pretreating Amsco 125-82 by scrubbing with concentrated sulfuric acid before degrading with hot nitric acid improved its stability. Aromatic diluents increase the radiation stability and extraction selectivity of TBP. The stabilities of the simple alkylbenzenes against nitration vary widely with the number of alkyl groups, their type, and their position, but a mixture of diethylbenzenes low in the para isomer and some of the polymethylbenzenes did not form fission product extractants in routine tests. Nitration of the benzene ring does not produce Zr–Nb extractants. 72 references. (auth)

**6900** INVESTIGATIONS TO DETERMINE THE EXTENT OF DEGRADATION OF TBP/ODORLESS KEROSENE SOLVENT IN THE NEW SEPARATION PLANT, WINDSCALE. A. J. Huggard and B. F. Warner (United Kingdom Atomic Energy Authority, Windscale, Cumb, Eng.). Nucl. Sci. Eng., 17: 638-50(Dec. 1963).

An experimental program to study solvent degradation in the New Separation Plant at Windscale is reported. To determine solvent life, TBP/odorless kerosene was recycled through an extraction, stripping, and solvent process system having similar residence times to those proposed for the design. Radiation was provided in a single stage by a strontium-90 source. The experiment was used to predict the effects of solvent degradation, as measured by Zr/Nb distribution, on the first cycle of purification and solvent washing. Examination of this degraded solvent from the recycle experiment by infrared analysis showed the presence of C=O, and $NO_3$ groupings, but no other groups were identified. Batches of solvent were degraded in a high $\gamma$-field at doses up to 125 watt-hr/liter in contact with nitric acid and uranyl nitrate, and were found to give high Zr/Nb retention in a standard $Z^2$ test, while the retention of Ru was found to be small with irradiations up to 35 watt-hr/liter; at 60 watt-hr/liter significant retention of the Ru was noted. The G-values for production of compounds containing carbonyl, carboxylic acid, nitrate, and nitrogroupings were determined in this series of irradiations. Synthetic long chain ($C_{12}$) ketones, carboxylic acids, nitro compounds, nitrites, nitrates, olefines, hydroxamic acids, nitro alcohols, and short chain ($C_4$) nitrolic acids were examined as possible ligands. Of these, only the hydroxamic acids give powerful retention of activity, and the zirconium complexes were sufficiently stable to withstand the extraction and washing conditions. Comparison of the batch degraded trials and the recycle trials showed that the pattern of products detectable by infrared analysis differed. The removal of ligands by the normal alkali washes used in the New Separation Plant was compared with that obtained with alkanolamines, alkaline permanganate, and fluoride solutions, and with purification by distillation techniques. (auth)

**6901** ECONOMIC ASPECTS OF THE TREATMENT OF IRRADIATED FUEL. Ugo Miranda. Riv. Ing. Nucl., 1: 135-40(May-June 1963). (In Italian)

The conditions under which the processing of irradiated fuel would be of economic interest are examined. Fuel elements with various enrichments from both power and research reactors are considered. The three factors analyzed in the study are the value of the recoverable material, the processing costs, and the transportation costs. An evaluation is first made of the annual quantity of irradiated fuel to be processed. (J.S.R.)

**6902** EXTRACTION OF URANIUM WITH MIXTURES OF TRIBUTYL PHOSPHATE AND DIISOAMYL ESTER OF METHYLPHOSPHONIC ACID. V. V. Fomin, R. E. Kartushovs, and E. P. Mayorova. p.37-46 of "Ekstraktsiya. Teoriya. Primeneie., Apparatura. Vol. 2." Moscow, Atomic Publishing House, 1962.

The distribution of $UO_2(NO_3)_2$ between aqueous solutions of $HNO_3$ (1 M), $HNO_3$ (0.05 M) + $NH_4NO_3$ (1 M), and solutions of the binary mixtures of extragants tri-n-butyl phosphate (TBP) + diisoamyl ester of methylphosphonic acid (DAMPA) in kerosene was investigated using $U^{233}$ and $U^{238}$. It was established that distribution coefficient ($\alpha$) of $UO_2(NO_3)_2$ during extraction with mixed extragants is greater than the additive value. In connection with this it was shown that along with the compounds $UO_2(NO_3)_2 \cdot 2$ DAMPA and $UO_2(NO_3)_2 \cdot 2$ TBP in the organic phase the formation of solvate $UO_2(NO_3)_2 \cdot$ DAMPA $\cdot$ TBP occurs, the stability constant of which is determined by the expression $K_3 - 2\sqrt{K_1 \cdot K_2}$. An example is given for calculating $\alpha$ for macro amounts of $UO_2(NO_3)_2$ distributed between 1 M solution of $HNO_3$ and the mixed extragant TBP (0.74 M) + DAMPA (0.075 M). (TCO)

**6903** EFFECT OF MONO- AND DIBUTYL PHOSPHATES ON THE EXTRACTION OF URANIUM(IV) WITH TRIBUTYL PHOSPHATE. V. B. Shevchenko and V. S. Smelov. p.37-46 of "Ekstraktsiya. Teoriya. Primeneie., Apparatura. Vol. 2." Moscow, Atomic Publishing House, 1962.

Using $U^{232}$ the distribution coefficients ($\alpha$) of U (+6) between aqueous solutions of $HNO_3$ of different concentrations (C′) and 20% solutions (by volume) of tri-n-butyl phosphate in hydrogenated kerosene contain variable amounts of monobutyl phosphoric (HA′) and dibutyl phosphoric (HA″) acids were measured at 20 ± 2°C. It was established that in the interval of C′ 1–6 mole/l with increase of concentration of HA″ in the organic phase ($C_D$) from 0.0013 to 0.5 M $\alpha$ U drastically increases, particularly in the lower regions of C′. Increase of concentration HA′($C_M$) does not influence significantly the extraction of U. When the ionic strength of aqueous phase $\mu$ = 4.0, then $\alpha$ U does not depend on C′ in the $HNO_3 + HClO_4$ system, it is inversely proportional to the square of hydrogen ion concentration in the $HNO_3 + LiNO_3$ system and is directly proportional to the square of $C_D$ and $C_M$ in benzene. On the basis of the data, the reaction of formation of mononuclear complexes of U (+6) with HA′ and HA″ is given by the equation: $UO_2^{2+}$ (aq) + 2HA (org) $\rightleftharpoons$ $UO_2K_2$ (org) + $2H^+$ (aq). The equilibrium constants for the reaction of HA′ and HA″ are calculated to be (2.28 ± 0.18)·10 and (4.92 ± 0.2)·10, respectively. The distribution of HA′ and HA″ between benzene and aqueous solutions of different composition was investigated. When $\mu$ = 4 in system (2) $\alpha$ HA″($C_D$ = 0.05M) and HA′($C_M$ = 0.01) increase slowly from 27.6 to 35.7 and from 0.41 to 0.49 with increase of C′ in the 1–4 mole/l interval. In system 1, $\alpha$ HA′ and HA″ are independent of C′. (Referativnyy Zhurnal, Khimiya, Vol. 14, 1963)

**6904** SEPARATION OF THORIUM FROM RARE EARTH ELEMENTS BY EXTRACTION WITH TRIBUTYL PHOSPHATE. G. E. Kaplan, S. D. Moiseyev, V. M. Gavrilin, G. I. Semenov, and V. P. Vorotilin. p.154-9 of "Ekstraktsiya. Teoriya. Primeneie., Apparatura. Vol. 2." Moscow, Atomic Publishing House, 1962.

Distribution coefficients ($\alpha$) of $Th(NO_3)_4$ between aqueous solutions of $HNO_3$ of different concentrations (C′) and 40% by volume solutions of tributyl phosphate (TBP) in xylene and hydrogenated kerosene (I) in the concentration range of Th in aqueous phase (C″) 30–130 g/l at room temperature were studied. As C′ increases from 1–8 mole/l $\alpha$ of Th passes through a maximum in the C′ 4–5 mole/l region and then significantly lowers. Increase of C′ leads to displacement of maximum position in the direction of lower values of C′. In the presence of rare earth elements (REE) (Nd, Sm, Gd) $\alpha$ of Th increases somewhat, however, with increase of concentration of (REE) in the aqueous phase the degree of separation of Th and REE practically does not change. By stepwise countercurrent extraction the separation of REE from Th has been conducted under the following conditions: C′ 4–4.5 mole/l; C″ 44–72.5 g/l; concentration of REE 7–22 g/l; extragant 40% solution (by volume) of TBP in I; wash solution 3.7–4.0 M $HNO_3$; the ratio of volumes of the organic, aqueous and wash solutions during extraction and washing were (1.5–1.9) : 1 : (0.5–0.7). There were seven extraction steps and six washing steps. After separation the content of REE in the purified Th was $<10^{-3}$ weight %. Description of the cell is given for the countercurrent type mixer-settler type. (Referativnyy Zhurnal, Khimiya, Vol. 14, 1963)

**6905** EXTRACTION OF THORIUM WITH DIISOAMYL ESTER OF METHYLPHOSPHONIC ACID FROM HYDROCHLORIC AND PERCHLORIC ACID SOLUTIONS. V. D. Nikol'skii and M. E. Pozharskaya. p.160-4 of "Ekstraktsiya. Teoriya. Primeneie., Apparatura. Vol. 2." Moscow, Atomic Publishing House, 1962.

Distribution coefficients ($\alpha$) of $Th^{234}$ between aqueous solutions of HCl and $HClO_4$ of different concentrations and 10–50% (by volume) solutions of diisoamyl ester of methylphosphonic acid (I) in $CCl_4$ were determined at 20 ± 1°C. It was established that in the concentration region of HCl in aqueous phase (C′) of 0.5–7 mole/l $\alpha$ of Th first increases linearly with increase of C′ and then more rapidly. With increase of Th concentration in aqueous phase (C″) $\alpha$ of Th only decreases (C′ = 5 mole/l; C″ varied from 1–230 mole/l). During extraction of macro quantities of Th the concentration ratio Cl : Th in the organic phase with increase of C′ (in 3–7 mole/l interval) changed slowly from 3 to 4. On the basis of these data and also the data on determination of slope of log $\alpha$ = f(log [I] argument), it was concluded that in the region of small C′ (0.5–4 mole/l) Th is extracted in the form of basic salt $ThOHCl_3 \cdot 2 \cdot I$, and in the C > 5 mole/l region in the form of neutral salt $ThCl_4 \cdot 2 \cdot I$. In the presence of $HClO_4$ Th is extracted with somewhat greater value of $\alpha$ than for HCl solutions. In this case the dependence of $\alpha$ has identical characteristics on concentrations of HCl and $HClO_4$. (OTS)

**6906** EXTRACTION OF URANIUM FROM HYDROCHLORIC ACID SOLUTIONS. B. N. Laskorin and V. A. Kuznetsov. p.209-18 of "Ekstraktsiya. Teoriya, Primeneie., Apparatura. Vol. 2." Moscow, Atomic Publishing House, 1962.

Measurements of distribution coefficient ($\alpha$) were made during the extraction of HCl and U (+6) and U (+4) chlorides with solutions of alkylphosphorus compounds and tri-n-octylamine (TOA) in different solvents. The extraction of HCl with neutral alkylphosphorus solvents (NFR) increases with increase of concentration of HCl in the aqueous phase (C′), and concentration of NFR in the organic phase. Extraction of HCl also depends on the solvent used. The distribution is adequately described by the equation: $H^+$ (aq) + $Cl^-$ (aq) + NFR (org) ⇌ HCl · NFR (org). TOA almost completely extracts HCl from solutions in which the starting molar concentration of HCl in the aqueous phase does not exceed the concentration of TOA in the organic phases. The equilibrium constant of the reaction $H^+$ (aq) + $Cl^-$ (aq) + TOA (org) ⇌ TOA · HCl (org) was found to be $\sim 10^3$. Diactyl ester of phosphoric acid (HA) practically does not extract HCl at low C′. The extraction of U (+6) with solutions of the investigated extragants in kerosene is made more complicated by the formation of TP. Addition of high molecular weight alcohols, which prevent stratification of TP, lower significantly $\alpha$ of U (+6). In the region of low C′ TBP, DAMPA, and TOA extracts U (+6) to an insignificant extent. With increase of C′ starting with 3–6 mole/l (depending on the nature and concentration of extragant) $\alpha$ is sharply increased and reaches a magnitude of several hundred when C = 7–9 mole/l. Further lowering of $\alpha$ is explained by the displacing action of HCl. The concentration in equilibrium constants of the reaction $UO_2^{2+}$ (aq) + $2Cl^-$ (aq) + 2NFR (org) = $UO_2Cl_2 \cdot 2NFR$ (org) do not retain constant value at high ionic strength of solution. Salting out action of the nonextracted chlorides and HCl increases according to the series TBP < DAMPA < TOPO. In the low concentration region of NFR significant deviations of $\alpha$ U (+6) from the quadratic dependence are observed. TOA extracts U (+6) from HCl solutions in the form of $(TOA \cdot H)_2 \cdot UO_2Cl_4$. The maximum capacity of TOA comprises 320 mg of U (+6) per 1 g of TOA. The presence of synergistic effects was established during extraction of U (+6) with mixtures of HA and NFR. Extraction of U (+6) with HA in the absence of NFR is described by the equation: $UO_2^{+2}$ (aq) + 2HA (org) ⇌ $UO_2K_2$ (org) + $2H^+$ (aq). Contrary to U (+6), U (+4) is significantly extracted by the investigated extragants at higher C′ (4–7 mole/l) and the maximum values of $\alpha$'s are shifted towards more acid side. In all cases under similar conditions $\alpha$ U (+4) is higher than $\alpha$ U (+6). On the basis of the conducted investigation it was shown that the composition of the extracted compounds corresponds to the formula: $UCl_4 \cdot 2NFR$ and $[TOA \cdot H]_2\ UCl_6$. Data are given on reextraction of U (+6) and U (+4) from the organic phase of different composition by means of water, aqueous solutions of $(NH_4)_2CO_3$, $Na_2CO_3$ and others. The extraction of alkali and alkaline earth chlorides was investigated as well as Th, Al, rare earth elements, $Fe^{2+}$, and $Cr^{3+}$ with all investigated extragants. An analogy was drawn between extractions from HCl and $HNO_3$ solutions. (TCO)

**6907** IMPROVEMENTS IN OR RELATING TO PLUTONIUM EXTRACTION. (to Commissariat a l'Energie Atomique). British Patent 945,184. Dec. 23, 1963. Priority date Aug. 17, 1960, France.

A process is given for obtaining concentrated Pu solutions in high purity and >99.5% yield from dilute Pu solutions. The process comprises the following steps: extracting Pu from and aqueous $HNO_3$ solution of irradiated fuel containing Pu in the tetravalent state, using a solution of tertiary amine in an organic solvent; separating the organic phase and scrubbing it with an aqueous $NHO_3$ solution; and then extracting the Pu from the scrubbed organic phase with an aqueous acid solution having an acidity >0.1N and a redox potential sufficient to maintain the Pu in the tetra-

valent state. The solution used for the re-extraction is either $H_2SO_4 - HNO_3$ or $HClO_4$, and this solution may be further scrubbed with an organic solution of tertiary amine. Several examples of this process are given using trilaurylamine. (D.L.C.)

**6908** HYDROMETALLURGICAL PROCESS FOR THE RECOVERY OF URANIUM. Mayer B. Goren (to Kerr-McGee Oil Industries, Inc.). U. S. Patent 3,115,388. Dec. 24, 1963. Filed Jan. 28, 1959.

A process for concentrating U values by acid leaching, solvent extraction, and stripping of the extractants is patented. The U ore is leached with aqueous sulfuric acid, and the U-containing leach liquor is contacted with a solution of water-insoluble organic amine solvent extractant. The resulting solution of U-loaded extractant is contacted with a stripping solution of a water-soluble inorganic sulfate. Na, K, Mg, or ammonium sulfates may be used, and the concentration should be at least 1 M in the stripping solution, which is at a temperature of 50 to 100°C. The stripping solution containing U is separated from the solution of U extractant, U is recovered from the stripping solution, and the solution may be recycled. The barren leach liquor may also be recycled in the leach circuit. (M.P.G.)

# ENGINEERING

## General

**6909** (AD-406690) ION PROPULSION. A Report Bibliography, January 1959–April 1963. C. S. Rank, comp. (Minneapolis-Honeywell Regulator Co. Aeronautical Div., Minneapolis). 36p. (RB-63-3)

References (275) to literature on ionic propulsion of the contact or bombardment type and on studies related to problems in ionic propulsion are included. The literature is from the period January 1959 through April 1963. (D.C.W.)

## Facilities and Equipment

**6910** (AERE-R-4297) GENERAL PURPOSE PLATINUM-LINED FURNACE DESIGN, TESTING AND OPERATION. D. N. Fletcher and L. J. White (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Apr. 1963. 20p.

A brief description is given of the design, construction, and testing of a laboratory general purpose platinum-lined furnace to operate at 1000°C with hydrogen fluoride gas purge. The description places on record some of the conditions which may arise when platinum is used at high temperature in close contact with chromium steel. Awareness of these conditions should enable a more rational design of furnace to be produced. (auth)

**6911** (GA-4635) MULTI-CELL IRRADIATION CAPSULES WITH INDEPENDENT INSTRUMENTATION AND TEMPERATURE-CONTROL FEATURES. K. Worth and D. G. Guggisberg (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Oct. 4, 1963. Contract AT(04-3)-187. 8p. (CONF-227-10)

From Problems in Irradiation–Capsule Experiments Conference, Germantown, Md., Oct. 1963.

The design features and performance of a three-cell capsule for fuel irradiations are outlined. Besides the separate instrumentation for automatic temperature control and measurement, a fission-gas sampling system is provided for each cell. The design features of a four-cell capsule currently being developed are also considered briefly. (D.L.C.)

**6912** (K-1568) A SINGLE-STAGE AXIAL COMPRESSOR BLADE TEST FACILITY. G. G. Fee (Oak Ridge Gaseous Diffusion Plant, Tenn.). Jan. 13, 1964. Contract W-7405-eng-26. 47p.

A general description is given of the single stage axial compressor blade test facility located at the Oak Ridge Gaseous Diffusion Plant, Oak Ridge, Tennessee. This facility, formally known as the Research Compressor Test Facility, has the instrumentation and equipment required to evaluate the performance of axial blades requiring maximum power inputs of 2500 hp and rotational speeds up to 23,000 rpm in a 14.5-inch diameter test section. The building layout, instrumentation, utilities, drive train and blade inspection equipment are described. (auth)

**6913** (NP-13409) A RESEARCH PROGRAM IN TWO-PHASE FLOW. (Centro Informazioni Studi Esperienze, Milan). Jan. 1963. 610p.

A full report is presented on the experimental work of CISE and Ansaldo on steam–water spray as a reactor coolant. The work, previously published in several topical reports, is part of the CAN-1 program and was performed between Nov. 1959 and April 1961. The work includes the following: burnout heat flux experiments on steam–water spray, hydrodynamics of high-pressure gas–liquid mixtures at room temperatures, corrosion of Zircaloy and stainless steel in wet steam, and mixing and separation of two-phase mixtures. (D.L.C.)

**6914** (NP-13436) IZUCHENIE IZNOSA OGNEVPORNOI FUTEROVKI DOMENNSI PECHI PRI POMOSHCHI RADIOAKTIVNYKH IZOTOPOV. (Investigation of the Wear of the Refractory Lining of Blast Furnaces by Means of Radioisotopes). L. Lebumka, M. Aleku, N. Andreesku, and K. Motsok (Academia R. P. R. Institutul de Fizica Atomica, Bucharest). June 1963. 19p.

Investigation and control of furnace lining wear by means of radioisotopes are described. Characteristics of $Co^{60}$, $Ag^{110}$, $Ta^{182}$, and $Zn^{65}$ as tracers are tabulated. (R.V.J.)

**6915** (SC-TM-297-63(73)) EFFECT OF TEMPERATURE CHANGE ON INTERNAL PRESSURE IN A HYDROSTATIC PRESSURE VESSEL. Harry A. Warrick and W. M. Sigmon (Sandia Lab., Albuquerque, N. Mex.). Nov. 1963. Contract AT(29-1)-789. 17p.

Results are presented of an investigation to determine the effect of variations in temperature of a pressurized fluid upon the internal pressure in hydrostatic pressure vessels. For a 6-in. × 7-in. pressure vessel completely filled with water, sealed, and pressurized, the pressure increases ~26 psi for each °F of temperature rise. However, if a small volume of air is trapped in the pressure vessel, the pressure change is much less. (D.L.C.)

**6916** IMPROVEMENTS IN OR RELATING TO FLUID TIGHT INTERCOMMUNICATION AND DISCONNECTING DEVICES. Jean Blin and Andre Valentin (to Commissariat a l'Energie Atomique). British Patent 946,313. Jan. 8, 1964. Priority date Nov. 6, 1959, France.

A fluid-tight intercommunication and disconnecting device was developed for placement between two fluid-tight chambers to permit the introduction or removal of contaminated products or materials from one chamber to the other and the separation of the chambers without the contamination being able to spread to the outside atmosphere. The device was adapted to be mounted one above the other with an opening in the floor of the upper chamber connecting to an opening in the top of the lower chamber. The covers were adapted to fit closely together and to cover the openings. Each cover and the upper chamber have a downward projecting peripheral flange. (M.C.G.)

**6917** IRRADIATION CAPSULE. (to Commissariat à l'Énergie Atomique). First Add. No. 78,282 to French Patent 1,261,979. May 21, 1962. Filed Aug. 25, 1960.

A capsule is described comprising a hermetically sealed tubular container for the sample. The sample is supported by a cylindrical sleeve of refractory material so that annular interspaces are formed between the container wall and the sleeve, and between the sleeve and the sample, and a heating coil is disposed within that sleeve. Lateral openings in the sleeve in the proximity of its extremities ensure the communication of those interspaces in order to allow a natural circulation of the fluid within the capsule. According to the present addition, means are provided for the determination of the fluid flow of the circulation, com-

prising an airscrew-like wheel rotatively mounted within the sleeve in the proximity of one end of the sample. According to a first embodiment, the wheel rotates freely and is provided with a pin-point radioactive source that passes periodically in front of a radiation counter. The frequency of the measuring signal of the counter is a measure of the fluid flow. According to another embodiment, the wheel is driven by an electric motor disposed within the capsule such as to control the fluid flow up to a given level. (IIB)

**6918** PROCESS OF OPERATION OF A WINDOW FOR A HIGH-ACTIVITY CELL. Georges Bonnet and Jean Petit (to Commissariat a l'Energie Atomique). U. S. Patent 3,114,945. Dec. 24, 1963. Priority date Sept. 3, 1959, France.

A method of preventing coloring and opacification of Pb glass windows by $\gamma$ radiation in high-activity cells is patented. Two identical glass windows are placed edge to edge in a frame, which can be moved along the cell wall containing a viewing aperture. Two protective screens are located on either side of the aperture far enough away from the cell walls to permit a glass window to slide behind it. While one window is in front of the aperture, the other window is behind a screen, which reduces the $\gamma$ radiation level below the opacification level of the glass. The glass windows can be moved as a unit, so that the window that was in front of the aperture is moved behind one screen while the window that was behind the second screen is moved in front of the aperture. Heating systems to accelerate the autoregeneration of the windows are located behind the protective screens. (M.P.G.)

## Heat Transfer and Fluid Flow

**6919** (63-RL-3357C) PHOTOGRAPHIC STUDY OF NUCLEATE POOL BOILING ON A HORIZONTAL SURFACE. R. F. Gaertner (General Electric Co. Research Lab., Schenectady, N. Y.). June 1963. 29p.

A photographic study was made of saturated nucleate pool boiling at a pressure of 1 atm. Over 1000 still photographs and 12 high-speed motion pictures were taken of water boiling from a 2-inch-diameter flat horizontal surface facing upwards. Two surfaces were studied, a 2/0 polished platinum surface and a 4/0 polished copper surface. The platinum surface was studied in the heat flux range of 14,700 to 176,000 Btu/hr $ft^2$, and the copper surface from the incipient boiling heat flux of 10,500 Btu/hr $ft^2$ to the maximum flux of 493,000 Btu/hr $ft^2$. Data were obtained for the breakoff diameters of discrete bubbles, and for the populations of active sites at heat fluxes up to 58,600 Btu/hr $ft^2$. At least three, and possibly four, heat transfer regions were found to exist in nucleate boiling, depending upon the mode of vapor generation. The vapor structures on the surface progressed through a sequence of first discrete bubbles, then vapor columns and vapor mushrooms, and finally vapor patches, as the surface temperature was increased. These individual vapor structures, or combinations of them, determine the mechanism of heat transfer in the four nucleate boiling regions. It was concluded that any heat transfer model or design equation which is based on the dynamics of individual bubbles, or on any other single mechanism, must be in serious error. (auth)

**6920** (AD-424629) THE MECHANISM OF VOID FORMATION IN INITIALLY SUBCOOLED SYSTEMS. Report No. 9041-26. Peter Griffith and George Snyder (Massachusetts Inst. of Tech., Cambridge). Sept. 1963. Contract Nonr-1841(39). 30p.

When an initially subcooled, water-filled system undergoes a transient in heat flux or pressure such that bubbles form, the most important variable which determines the volume of the resulting void is the number of bubbles that are formed. The number of bubbles that are formed is shown to be a function of the surface micro-configuration, the contact angle, and the history. A method of specifying the history is developed, experiments are run, and the general correctness of the history specification is shown to be correct. Order of magnitude values of the limiting wall superheats as a function of the surface history and configuration are presented, but the reproducibility of the experiments is not found to be high. (auth)

**6921** (ANL-6779) TWO-PHASE CRITICAL FLOW WITH APPLICATION TO LIQUID-METAL SYSTEMS (MERCURY, CESIUM, RUBIDIUM, POTASSIUM, SODIUM, AND LITHIUM). Hans K. Fauske (Argonne National Lab., Ill. and Associated Midwest Universities, Lemont, Ill.). Oct. 1963. Contract W-31-109-eng-38. 49p.

Existing data and models for critical two-phase flow of steam–water mixtures are examined. One model in particular shows considerable success in predicting the phenomena of critical flow. A Fortran program for an IBM-704 digital computer, for the application of this model to predict void fraction, slip ratio, and critical flow rates to the flashing flow for various liquid-vapor metal systems in pipes when the conditions are such that critical flow may be experienced, was developed. Calculations were made for the following liquid-metal systems: mercury (temperature range, 450 to 1600°F), cesium (temperature range, 500 to 2300°F), rubidium (temperature range, 500 to 2300°F), potassium (temperature range, 900 to 2500°F), sodium (temperature range, 950 to 2500°F), and lithium (temperature range, 2000 to 3500°F). The vapor fraction or quality ranges from 0 to 100%. It is shown that the critical flow rates for liquid-metal systems calculated from the best model describing steam–water data are considerably higher in the low-quality region than predicted from a so-called "homogeneous flow model." This is explained by the large slippage between the liquid and the vapor phases, because the ratio of the densities of the liquid state to the vapor state is usually large for metallic fluids. (auth)

**6922** (IDO-16867) HEAT 1—A ONE DIMENSIONAL TIME DEPENDENT OR STEADY STATE HEAT CONDUCTION CODE FOR THE IBM-650. R. J. Wagner (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Apr. 1963. Contract AT(10-1)-205. 76p.

An IBM-650 program that obtains a numerical solution to the one-dimensional heat conduction equation in slab or cylindrical coordinates is described. The solution is obtained using a finite difference approximation to the partial differential equation derived by an integral method. The boundary conditions are of the form that a factor times the temperature plus a factor times the gradient equals a time dependent quantity. Steady-state or time-dependent solutions can be obtained. (auth)

**6923** (ORNL-TM-703) PRESSURE-DROP CHARACTERISTICS OF CIRCULAR DUCTS CONTAINING SEPTAFOIL ROD CLUSTERS. G. J. Kidd, Jr. and J. L. Wantland (Oak Ridge National Lab., Tenn.). Oct. 15, 1963. Contract [W-7405-eng-26]. 25p.

Experimentally determined values of the bare-tube friction factor and support-spacer loss coefficients are given for four different ducts containing clusters of seven rods. Two of the geometries were models of the GCR-II and EGCR fuel elements. The results show the bare-tube friction factor to be consistently higher than the Blasius approximation for flow inside smooth, round tubes. Conserv-

ative correlations over the Reynolds modulus range from 15,000 to 80,000 can be expressed by $f = 0.12\ N_{Re}^{-0.14}$ for geometries in which the length-to-diameter ratio is less than 50 and $f = 0.24\ N_{Re}^{-0.22}$ for those in which it is greater. Support and spacer loss coefficients vary from 0.34 to 0.51 and can be calculated from contraction-expansion and orifice equations for the simpler configurations. (auth)

**6924** (RT/EL(63)-6) SIMULATORE DI SCAMBI TERMICI. (Simulator for Heat Exchanges). G. C. Ambrosini and D. Malosti (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). June 1963. 24p.

A special block of analog computation to be used for heat exchanges or pure lags simulation is shown. Temperatures are represented by voltages, heat flux by currents, and capacities and thermic resistances by similar electric elements. Transport phenomenon is represented by commutation of static elements. The equipment is all solid state. (auth)

**6925** (SAN-1004) ON THE PREDICTION OF VOID VOLUME IN TRANSIENT SATURATED POOL BOILING. C. L. Tien, V. E. Schrock, and H. A. Johnson (California. Univ., Berkeley. Inst. of Engineering Research). Dec. 1962. Contract AT(11-1)-34. 30p.

The previous work on the prediction of void volume in transient saturated pool boiling is re-examined for the purpose of improving the established prediction. A general mathematical formulation of transient-void-volume prediction is presented. The feasibility of having a complete solution relies much on such formidable problems as the correct bubble-growth law and the correct relationship among heat flux, temperature difference, and nucleation site density in the transient boiling. Instead, a simple model is advanced and its results are compared with available experimental data. The effect of pressure on void volume is analyzed. (auth)

**6926** (TID-19845) THE MECHANISM OF BURNOUT IN INITIALLY SUB-COOLED FORCED CONVECTIVE SYSTEMS (thesis). Thomas M. Grace (Minnesota. Univ., Minneapolis). Dec. 1963. Contract AT(11-1)-926. 142p.

An analysis is made of burnout in convective two-phase systems with particular emphasis directed toward understanding the physical mechanisms. Various aspects of two-phase flow were examined including flow regimes, film flow and entrainment, and two-phase heat transfer as well as direct burnout experiments. The information on two-phase heat transfer indicates that there are two distinct types of burnout, the first due to breakdown of nucleate boiling, and the second due to transition from convection-dominated heat transfer to a liquid-deficient heat transfer region. This analysis is concerned only with this second type of burnout. The analysis indicates that the pre-burnout conditions are dominated by the flow of liquid in a thin film on the heated surface, and that burnout occurs when this film flow dries up. The rate of supply of liquid to the heated surface by diffusion of droplets from the core may be considered negligibly small when a heat flux is present. This means there is a great difference between systems which are initially subcooled, and those in which a dispersed two-phase feed is used. The postulate that burnout conditions for dispersed feed systems are determined in the entrance region before the start of the heated section allows a qualitative prediction of several effects observed in these systems. The film flow mechanism was used to derive equations for burnout in initially subcooled systems based on a model considering removal of liquid from the film by evaporation and entrainment. This model gives a reasonably good correlation of burnout data. The results indicate that a model which is not based on droplet diffusion can correlate burnout data quite well, and that in fact droplet diffusion in the heated section has little effect on burnout. (auth)

**6927** (TID-19860) ON THE MECHANICS OF VAPOR BUBBLE COLLAPSE—A THEORETICAL AND EXPERIMENTAL INVESTIGATION. Final Report 2. L. W. Florschuetz and B. T. Chao (Illinois. Univ., Urbana. Engineering Experiment Station). Oct. 1963. Contract AT(11-1)-1069. 129p. (ME-TN-1069-2)

The mechanics of vapor bubble collapse under spherically symmetrical conditions is examined with a view to ascertain the relative importance of the effects of liquid inertia and heat transfer on the collapse rate. Equations governing the motion of the bubble wall were cast into appropriate dimensionless forms which led to a logical classification of the collapse mode into three categories: (i) where the collapse is controlled by liquid inertia, (ii) where heat transfer from the bubble to the liquid is the controlling mechanism, and (iii) where both effects are of comparable importance. The classic case studied by Rayleigh belongs to category (i). Two simple, but approximate solutions have been obtained for category (ii) using, respectively, the "plane interface" approximation and Plesset-Zwick's "zero-order" solution for the bubble wall temperature. Numerical solutions are given for cases where both heat transfer and liquid inertia effects are retained. A single dimensionless parameter is identified which may be used to characterize the mode of collapse, provided it is properly evaluated. Discriminating values of this parameter are suggested for the simple case where the collapse is initiated by a step change in pressure or temperature. For heat transfer controlled collapse, a model is also proposed to account for the influence on the collapse rate of a permanent gas present in the bubble. Experimental results for bubbles collapsing in water and ethyl alcohol are presented. Bubbles were photographed while collapsing in a near zero-gravity field, to approximate a spherically symmetrical process. Data are presented for bubbles with initial radii from 0.3 cm to 0.9 cm collapsing at atmospheric pressures under pressure differences ranging from 12 cm Hg to 63 cm Hg. The corresponding degrees of subcooling are 5 to 45°C. Data are also presented for vapor bubbles containing significant quantities of permanent gas. Within the limits of the experimental investigation, the data confirm the results and trends predicted from the theoretical analysis, both as to the mode of collapse and the influence of a permanent gas. Departures from spherical symmetry occurred in some cases due to the unstable nature of the collapse, or for slowly collapsing bubbles due to relatively small translational velocities. An interpretation of these observations is presented and discussed. (auth)

**6928** (AEC-tr-6252) HEAT TRANSFER IN FILM BOILING OF A STEAM–WATER MIXTURE IN STEAM-GENERATING TUBES. Z. L. Miropol'skii. Translated for Westinghouse Electric Corp., Bettis Atomic Power Lab., Pittsburgh), from Teploenerg., 10: No. 5, 49-52(1963). 10p.

A study was made of the effects of tube geometry on the temperature regime of tubes. Experiments were carried out on steam–water mixtures passed through a heated, vertical tube whose wall temperature was measured at different distances from the beginning of the heated section. The results showed that below 180 abs atm, deterioration of the temperature regime appeared in the initial sections of the heated tube at higher steam contents than in sections further away from the heated section. At pressures >200 abs atm, the heated length had no effect. Heat transfer coefficients were calculated. (D.L.C.)

**6929** TECHNIQUE FOR MINIMIZING THE SPECIFIC WEIGHT OF A FINNED BERYLLIUM SPACE RADIATOR. Bruno S. Leo (Hughes Aircraft Co., Culver City, Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 2847-8(Dec. 1963).

A beryllium radiator having a fin of triangular cross section and containing a wettable liquid metal in the tube for power plant cooling is discussed. A technique for minimizing the specific weight of a small-diameter beryllium tube with a short and thin triangular fin is presented. This technique permits thermal conductivity to vary with temperature and can be used for any fin profile. It also allows the temperature of the base of the fin to vary, accounts for the weight of the radiator fluid and pump, and includes the effect of these parameters in the optimization of the specific weight of the radiator. (C.E.S.)

**6930** DYNAMICS OF VAPOR BUBBLES IN SPHERICALLY SYMMETRIC TEMPERATURE FIELDS OF GENERAL VARIATION. L. A. Skinner and S. G. Bankoff (Northwestern Univ., Evanston, Ill.). Phys. Fluids, 7: 1-6(Jan. 1964).

During the growth of a spherical vapor bubble in a superheated liquid the inertial and surface tension effects rapidly become negligible, so that most of the growth occurs in an asymptotic stage characterized by an essentially constant bubble pressure. The asymptotic bubble behavior in initially nonuniform temperature fields is studied. An explicit formula for the bubble radius relation for a general spherically symmetric initial condition is derived. Application is made to the problem of nucleate boiling on a heated surface, where two dimensionless parameters are found to be important. Bubble radius vs time curves are determined and presented graphically for typical values of these parameters. Plots of maximum bubble radius, the time at which the maximum occurs, and the average growth velocity are given for the case of subcooled boiling. (auth)

**6931** ELECTRICAL CHARACTERISTICS OF COUETTE AND STAGNATION BOUNDARY-LAYER FLOWS OF WEAKLY IONIZED GASES. Paul M. Chung (Aerospace Corp., San Bernardino, Calif.). Phys. Fluids, 7: 110-20(Jan. 1964).

The electric behavior of weakly ionized, compressible gases flowing along a solid boundary is studied. Analysis is made for flows wherein the range of electrical effects, such as the sheath thickness, is much greater than the mean free path between the charged and the neutral-gas particles. The relation between the surface potential, currents, and the boundary-layer flow parameters are analyzed. (auth)

**6932** HEAT TRANSFER SODIUM CIRCUIT AND OPERATIONAL EXPERIENCES. Miroslav Pasek. Bull. Inst. Politeh. Iasi, 8: No. 3-4, 93-108(1962).

The characteristics and components of two sodium heat-transfer loops are described. Instruments for making measurements on the loops are discussed. Operation and operational disturbances in the loops are reviewed. (T.F.H.)

**6933** BUBBLE DYNAMICS AND NUCLEATE BOILING HEAT TRANSFER IN BINARY LIQUID MIXTURES. Wen-jei Yang (Univ. of Michigan, Ann Arbor). New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-197, 8p, $1.00. (CONF-102-22)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

The analysis of bubble growth in a superheated binary mixture by application of the source theory is briefly reviewed. The result of the analysis is then applied to nucleate-boiling heat transfer rates in binary liquid mixtures. Two correlations are proposed and results are compared with experimental data for water-ethylene glycol, water–ethanol, water–n–butanol and acetone–ethanol. The correlations as applied to pure liquids are found to represent data satisfactorily. (auth)

## Materials Testing

**6934** (ORNL-TM-680) ENERGY ABSORPTION CAPABILITY OF STEEL DETERMINED FROM CASK IMPACT TESTS. D. W. Goodpasture and L. B. Shappert (Oak Ridge National Lab., Tenn.). Jan. 6, 1964. Contract W-7405-eng-26. 74p.

The object of the studies discussed is to determine the amount of energy absorbed by the steel shells of a 2600-pound cask falling horizontally from a height of 23 ft. In addition, information is presented which will help predict the failure of similar casks dropped from different heights. The results of 22 drop tests are summarized. Included in the 22 tests were five tests of larger casks, weighing about 11,350 lbs. The larger cask test results compared favorably with the smaller cask test results. (auth)

**6935** (SC-TM-284-63(72)) NONLINEAR VIBRATION. J. V. Otts (Sandia Lab., Albuquerque, N. Mex.). Nov. 1963. Contract AT(29-1)-789. 29p.

Nonlinear vibration is discussed and compared with linear vibration. Nonlinear vibration phenomena are described, and methods for testing a nonlinear system, collecting and analyzing the data, and interpreting the results are suggested. (D.L.C.)

**6936** (TID-19919) STUDIES OF THE FATIGUE STRENGTH OF PRESSURE VESSELS. 1. CYCLIC PRESSURE TESTS OF LARGE SIZE PRESSURE VESSELS. 2. EFFECTS OF NOTCHES AND WELD DEFECTS ON PRESSURE VESSEL FATIGUE STRENGTH. Progress Report No. 5. A. G. Pickett and W. R. Schmidt (Southwest Research Inst., San Antonio). Nov. 8, 1963. Contract AT(11-1)-1228. 33p.

The fatigue strength of pressure vessels are being studied by the following programs: cyclic pressure tests of large pressure vessels, effect of flaws and weld defects on the plastic fatigue strength of A302B pressure vessel steel, and the effect of plastic fatigue on the notch ductility of mild steel plate. Progress is reported on stress analysis, out-of-roundness stresses, ultrasonic inspection, pressure cycling, weld defects, and notch ductility. (N.W.R.)

**6937** GAMMA RAY RADIOGRAPHY. Mark R. Rosumny (Picker X-Ray Corp.-Research Center, Cleveland). 19p. (CONF-356-5)

From 1963 American Society of Metals/Metals and Materials Show, Cleveland, Oct. 1963. 23rd National Convention of the Society for Nondestructive Testing.

A review is presented on gamma radiography. Sensitivity and radiation protection requirements are also discussed. (P.C.H.)

**6938** FULL-SIZE, PRESSURE-VESSEL TESTING AND ITS APPLICATION TO DESIGN. Lambert F. Kooistra (Babcock and Wilcox Co., Barberton, Ohio), E. A. Lange and Andrew G. Pickett. New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-293, 16p, $1.00. (CONF-102-28)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

The results of full-size pressure-vessel tests are summarized and used to demonstrate the validity of certain design procedures. In particular, design for low-cycle

(plastic) fatigue strength and fracture safety is investigated. The results justify given design stress recommendations, and confirm a particular fracture analysis diagram procedure hypothesis. It is emphasized that full advantage can be taken of high strength materials only by improvement of fabrication and inspection procedures. (auth)

**6939** THICKNESSES OF CLADDING OF NUCLEAR FUEL ELEMENTS DETERMINED BY X-RAYS. Paul Lublin. p.1045-9 of "Encyclopedia of X-rays and Gamma-rays." New York, Reinhold Corp., 1963.

The use of x-ray analysis techniques for measuring Al, 304 stainless steel, and Zr cladding thicknesses of nuclear fuel elements is discussed. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

## Protective Structures

**6940** (NP-13459) DESIGN OF OPENINGS FOR BURIED SHELTERS. Nathan M. Newmark (Waterways Experiment Station, Vicksburg, Miss.). July 1963. Contract DA-22-079-225. 329p.

A study is made of the design of low-cost protection of shelter openings against blast and radiation. The basic design considerations are outlined, and the structural and mechanical elements of the shelter entrance system are considered separately. Dimensions and geometry of entrance systems and ventilation systems are also considered. Radiation and blast effects and their influence on design are discussed. A general design procedure is outlined, and an example design solution is presented. (D.L.C.)

**6941** SELF-CLOSING COVER PLATE FOR AIR SHAFTS OR EMERGENCY EXITS OF SHELTERS, PARTICULARLY UNDERGROUND SHELTERS. Margot von Linsingen. British Patent 945,782. Jan. 8, 1964. Priority date July 3, 1961, Germany.

A self-closing cover plate assembly was designed for a ventilation shaft or emergency exit of a shelter, for example an underground air raid shelter. The assembly consists of a cover plate with a guide rod arranged as a piston for cooperation with a pneumatic cylinder for lifting in which the guide rod can slide. The cover plate is maintainable in an open position and is releasable by the action of trip means responsive to a sudden change in a predetermined characteristic of the ambient atmosphere. The trip means is coupled to a solenoid valve connected to an outlet conduit of the lifting cylinder to cause the outlet conduit to be opened instantaneously on the occurrence of the sudden change so that the cover plate falls freely with the guide rod toward a fully closed position. The outlet conduit has a throttle valve for cooperation with a cam associated with the cover plate to decelerate its fall. (M.C.G.)

## Vacuum Engineering

**6942** PRESSURES BELOW $10^{-12}$ TORR WITH A MEDIUM-SIZED ION PUMP. Lewis D. Hall (Ultek Corp., Palo Alto, Calif.). Vide, 18: 479-81(Sept.-Oct. 1963).

The ultimate vacuum obtainable by an unaided 400-liter/sec ion pump is studied. By baking-out the pump, pressures are obtained that are certainly no higher than 1 ptorr. The pressures obtained cannot be measured accurately, because of instrumental inaccuracies in this pressure range. (T.F.H.)

# GEOLOGY AND MINERALOGY

## General

**6943** ISOTOPE RATIOS IN MARINE MOLLUSK SHELLS AFTER PROLONGED CONTACT WITH FLOWING FRESH WATER. J. N. Weber (Pennsylvania State Univ., University Park) and A. La Rocque. Science, 142: 1666 (Dec. 27, 1963).

The ratios $C^{13}/C^{12}$ and $O^{18}/O^{16}$ in the calcium carbonate of shells of the marine mollusk, Macoma calcarea, appear unaltered after exposure for 4500 yr to flowing fresh water of higher $O^{16}/O^{18}$ ratio. (auth)

## Natural Radioactivity and Fallout

*Refer also to abstract 6973.*

**6944** (HASL-142) FALLOUT PROGRAM QUARTERLY SUMMARY REPORT, SEPTEMBER 1, 1963 THROUGH DECEMBER 1, 1963. Edward P. Hardy, Jr., Joseph Rivera, and William R. Collins, Jr. (New York Operations Office. Health and Safety Lab., AEC). Jan. 1, 1964. 342p.

Current data are presented from the HASL Fallout Program, the New Zealand Department of Scientific and Industrial Research, and the Dominion X-Ray and Radium Laboratory in New Zealand. Radionuclide levels in fallout, milk, tap water, diet, and upper air samples are given in tabular form. Also included are interpretive reports and notes dealing with fission product concentrations in the upper atmosphere, cumulative $Sr^{90}$ deposition levels from analyses of soils collected in 1962, and measurements of $Cs^{137}$ in the 1962 wheat crop. The production of and decay schemes for Cd isotopes generated in a high altitude 1962 U. S. nuclear test are covered in a series of three reports. A listing of announced nuclear detonations and tables excerpted from published sources on the fission and total yields of nuclear tests precedes a report on inventories of selected radioisotopes from nuclear testing. A bibliography of recent literature pertinent to fallout studies is included. (auth)

**6945** (HW-SA-3198) GROUND WATER EXCHANGE WITH FLUCTUATING RIVERS. J. R. Raymond and D. J. Brown (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 13, 1963. Contract AT(45-1)-1350. 27p. (CONF-293-1)

From 4th Hydraulic Conference, Pullman, Wash., Oct. 1963.

The behavior of ground water adjacent to fluctuating rivers, lakes, or reservoirs is discussed. Information is presented from studies on water behavior adjacent to fluctuating rivers concerning bank storage and river water penetration into ground water aquifers. Methods of investigation are described. Results are reported from an evaluation of bank storage and river water exchange for a site on the Columbia River at the Hanford site for which a large amount of geologic and hydrologic data was available. (C.H.)

**6946** (NP-13423) SUMMARY OF THE OBSERVATION RESULTS FOR NUCLEAR RADIATION IN THE WORLD DURING IGY-IGC. PART IV. (Japan. Meteorological Agency, Tokyo). Mar. 1963. 150p.

Data from various stations on the radioactivity of airborne dust, natural radioactivity, radioactivity of sea water and precipitation, and the deposition of radioactivity are compiled. Observations of fallout and abnormal microbarometric oscillations in Japan resulting from nuclear tests in 1961 and 1962 are also discussed. (D.C.W.)

**6947** (PNE-229F) SOME RADIOCHEMICAL AND PHYSICAL MEASUREMENTS OF DEBRIS FROM AN UNDERGROUND NUCLEAR DETONATION. W. B. Lane (Naval Radiological Defense Lab., San Francisco). June 1963. Project SEDAN. 130p.

Fallout samples were collected from 2600 feet to 19,000 feet from ground zero in order to determine the mass per unit area, gamma activity per unit area, particle size distribution, and specific activity versus particle size of the fallout; to determine the gamma decay rate and spectra of the samples; to perform leaching and exchange studies on the radioactive debris; to measure the release of gaseous fission product iodine; and to determine the radiochemical composition of the fallout particulate. Twenty collectors (2 ft × 2 ft × 2 in. deep) were placed in the downwind sector at increasing distances. An iodine gas sampler was located approximately two miles downwind. The fallout was well distributed over the station array, and all collectors received significant deposits. Analysis of the debris was performed at the Nevada Test Site. Airborne iodine fission products were found in the contaminated field downwind from ground zero, and iodine fission products were found to volatilize or be otherwise released from particulate fallout. Gamma-decay measurements showed no evidence of radionuclide fractionation in debris from different locations, nor among different particle size fractions. Pulse-height distributions also indicated no significant fractionation of gamma-emitting radionuclides. A 4-$\pi$ ionization chamber decay rate measurement showed excellent agreement with a computed decay rate. Measurements of mass and activity distributions indicate that the radionuclides are associated with the volume of the particle rather than with its surface area. Radiochemical data are presented, but extensive analysis was not attempted. (auth)

**6948** (RISO-65) ENVIRONMENTAL RADIOACTIVITY IN GREENLAND IN 1962. A. Aarkrog, J. Lippert, and J. Petersen (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). July 1963. 28p.

Results are reported from measurements of environmental radioactivity from fallout in Greenland in 1962. Data are included on the $Sr^{89}$, $Sr^{90}$, and $Cs^{137}$ content in samples of precipitation, drinking water, sea water, soil, vegetation, and human diet. (C.H.)

**6949** (SCPRI(RM)X-1963) RAPPORT D'ACTIVITE, OCTOBRE 1963. (Report of Activities, October 1963). (France. Service Central de Protection contre les Rayonnements Ionisants, Paris). 21p.

The results of the radiological monitoring of the atmosphere, nuclear sites, rain water, the food chain, and sea water are briefly summarized and shown graphically and in tabular form. (J.S.R.)

**6950** (SCPRI(RM)XI-1963) RAPPORT D'ACTIVITE, NOVEMBRE 1963. (Report of Activities, November 1963). (France. Service Central de Protection contre les Rayonnements Ionisants, Paris). 16p.

An account is given of radiation monitoring in ground-level and high-altitude air; rainwater; sea water; plants, animals, and milk; and nuclear sites in France. (T.F.H.)

**6951** (UCLA-518) INCREASED ENVIRONMENTAL RADIATION IN SOUTHERN NEVADA, OCTOBER–DECEMBER 1961. William E. Martin and Frederick B. Turner (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). July 1963. Contract AT-04-1-GEN-12. 44p.

Radiochemical and statistical analyses were made on samples of soils, plants, and animals collected in October and early November 1961 from areas at and near the Nevada Test Site. Similar samples collected after the Kiwi B-1a reactor test of December 7, 1961, were analyzed. Radioactivity in all samples tended to decrease with increasing distance from the test site. Increases of environmental radiation attributable to the Kiwi reactor were minor and highly localized. The major increase in environmental radioactivity in southern Nevada during November 1961 was due to fallout from nuclear detonations in the USSR. (C.H.)

**6952** STRONTIUM-90: CONTRIBUTION TO THE STUDY OF STRATOSPHERIC FALLOUT AND ACCUMULATION ON THE EARTH. Carmelo Cappadona and Giovanni Fierotti (Università, Palermo, Italy). Atti Accad. Sci., Lettere Arti Palermo, Pt. I, 22: 1-12 (1961-62) (Pub. 1963). (In Italian)

During 1962, fallout activity and its content in $Sr^{90}$ were determined monthly and large variations of $Sr^{90}$ in fallout were found. Some details of this phenomenon agree with the supposition of different $Sr^{90}$ stratifications in the biosphere. The total amount of $Sr^{90}$ deposition during 1962 only was the same as the $Sr^{90}$ content in soil in December 1961, that is in a year its content has doubled. (P.C.H.)

**6953** MEASUREMENTS OF THE RADIOACTIVITY OF RAIN. M. C. Romano (Università, Palermo, Italy). Atti Accad. Sci. Lettere Arti Palermo, Pt. I, 22: 3-16 (1961-62) (Pub. 1963). (In Italian)

Observations made from September 1961 on radioactivity of single rainfalls with maxima in consequence of nuclear tests of remarkable power are discussed. The decay of the radioactivity showed the presence of several fission products. The atmospheric scavenging action of the rain is pointed out though there is not an immediate relation between the values of radioactivity in rain and in air day by day. (P.C.H.)

**6954** THE NATURAL RADIOACTIVITY OF THE ATMOSPHERE. W. Jacobi (Hahn-Meitner-Institut für Kernforschung, Berlin). Biophysik, 1: 175-88(1963). (In German)

On the basis of experimental and theoretical investigations, a quantitative review of the distribution and deposition of $Rn^{222}$, $Rn^{220}$, and their decay products in the atmosphere is given. With the help of an expanded exchange theory, in which the height dependence of the atmospheric turbulence and the deposition of the decay products are considered, the vertical distribution of the natural radioisotopes in the atmosphere was calculated. The results agreed well with previously obtained experimental results. The formation of natural radioactive aerosols in the atmosphere was investigated and the size distribution given. The processes for the deposition of Rn decay products are discussed and the resulting radioactivity in precipitation given. (tr-auth)

**6955** A COMPARISON OF NATURAL AND FALLOUT RADIOACTIVITY IN ONTARIO SOILS UNDER PINE. Eville Gorham (Univ. of Minnesota, Minneapolis). Can. J. Botany, 41: 1309-18(Sept. 1963).

Radioactive fallout is strongly concentrated in the organic litter layers of pinewood soils, which exhibit gross beta activities as high as or higher than those of living pine needles. Radioactivity of the ash from litter layers sampled in the spring of 1962, after resumption of thermonuclear-weapon testing by the USSR, was about 12 times that exhibited during the early month of 1961, and about 30 times the natural beta activity before worldwide thermonuclear fallout. Mineral soils sampled during these same periods generally showed relatively slight differences in ash activity. Leaf litter from angiosperm trees was more highly radioactive than litter from gymnosperm trees, on both the ash and dry-weight basis. (Public Health Eng. Abstr., 43: Dec. 1963)

**6956** CONSERVATION OF RADIOGENIC ARGON IN SYLVITES. Yu. A. Borshchevskii and S. L. Borisova (Moscow State Univ.). Geokhimiya, No. 11, 1055-7(Nov. 1963). (In Russian)

A new interpretation is offered for the argon losses in non-recrystallized sylvite. It is shown that all non-recrystallized sylvites, indicating earlier age periods, were of various hues of red because of inclusions of hematite. An analysis was made of white, rose, and red sylaites of the Starobinskii deposit and the content of hematite responsible for the red hues was estimated. The age determination with white sylvites was 340 million years which was in good agreement with the geochronological data scale of 1960. Colored sylvites indicated lower age, with the strongest colors indicating the more recent dates. It was shown that non-recrystallized white sylvite free of hematite can be used for determining the absolute age of various mineral deposits. (R.V.J.)

**6957** DETERMINATION OF THE COEFFICIENT OF RADIOACTIVE DUST CAPTURE BY RAIN. K. P. Makhon'ko. Izv. Akad. Nauk SSSR, Ser. Geofiz., No. 11, 1709-17(Nov. 1963). (In Russian)

Rain scavenging of radioactive particles was analzyed. Estimates of the mean daily dust concentrations of up to 1 year old fractions during dry and wet weather were used for determining the rain drop capture coefficient. (R.V.J.)

**6958** AN ESTIMATE OF THE RATE OF NATURAL RADIOACTIVE AEROSOL FROM THE ATMOSPHERE BY CLOUDS AND PRECIPITATION. I. L. Karol. Izv. Akad. Nauk SSSR, Ser. Geofiz., No. 11, 1718-29(Nov. 1963). (In Russian)

A method is suggested for determining the mean rate of radon scavenging from the lower troposphere by clouds and precipitation. Vertical turbulent diffusion is considered. Data are included on the mean rate of aerosol wash out by precipitation. (tr-auth)

**6959** GAMMA-EMITTING NUCLIDES IN FALLOUT ASSOCIATED WITH ATMOSPHERIC TESTING DURING THE AUTUMN OF 1961. H. M. Yakabe, J. M. Dimitroff, and E. P. Laug (Food and Drug Administration, Washington, D. C.). J. Assoc. Offic. Agr. Chemists, 46: 941-6 (Dec. 1963).

Type of emission and energy of emission of fission products were investigated to determine the radioisotopes, detectable by gamma spectroscopy, that were due to fallout from atmospheric testing during the autumn of 1961. Gamma spectra made from a sample of lawn grass collected in the Washington, D. C. area demonstrate the decay of characteristic photopeaks. (auth)

## Site Survey and Selection

**6960** PROBLEMS OF APPLYING FIXED FORMULAE TO SAFETY CRITERIA AND SITE SELECTION. W. Kenneth Davis (Bechtel Corp., San Francisco). 9p. (CONF-358-1)

From American Nuclear Society Fall Meeting, Rochester, N. Y., Oct. 1963.

The problem of developing a formula or calculation procedure for that could more-or-less automatically indicate whether or not a nuclear plant would be considered safe at a particular location is discussed. The difficulties and impossibilities of any such formula for making decisions on siting and safety involving large amounts of money and public safety are considered. (P.C.H.)

## Techniques and Equipment

*Refer also to abstract 7049.*

**6961** POSSIBLE USE OF $Ca^{41}$ IN NUCLEAR DATING. Yoshio Yamaguchi (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 30: 567(Oct. 1963).

Since Ca is one of the major constituents of bones, shells, and their fossils, it is suggested that the radioisotope $Ca^{41}$ would be useful in nuclear dating. Some of the sources of $Ca^{41}$ in nature are discussed. (C.E.S.)

**6962** METHOD OF CONTROLLING WELL FLUID CIRCULATION BY RADIOACTIVATION OF FLUID ELEMENTS. James A. Rickard (to Jersey Production Research Co.). U. S. Patent 3,115,576. Dec. 24, 1963. Filed July 31, 1959.

A method of determining any unbalance in the circulation of fluid during well drilling is patented. Fluid is circulated through the boreholes of wells being drilled by the rotary method. A change in the rate of discharge of the fluid, so that it is not the same as the input rate, is an early signal of abnormal conditions within the well. A material is added to the fluid, which can be made radioactive with a half life of 0.1 to 100 sec by bombardment with nuclear particles. Radioactive sources are mounted outside the fluid inlet and outlet pipes, and detectors are placed outside the pipes downstream of the sources. The activity of the material at the detecting points is compared, and a change in the relative flow rates is indicated by a change in the relative activity. (M.P.G.)

**6963** RADIOACTIVITY WELL LOGGING FOR CARBON DETERMINATION. Hugh E. Hall, Jr. and Alexander S. McKay (to Texaco Inc.). U. S. Patent 3,115,579. Dec. 24, 1963. Filed Jan. 7, 1957.

A method of analyzing earth formations in a bore hole for the presence of C, using fast neutrons is patented. The formation along a bore hole is irradiated with neutrons from a well-logging instrument having an energy range from 4.8 to 6.5 Mev. Inelastically produced $\gamma$ rays of the order of 4.43 Mev are selectively detected as an indication of the presence of C in the formation. The hydrocarbon content of the formation may be determined by separately detecting the fast neutrons transmitted from source to detector through the formation. This signal is proportional to the number of H nuclei in the formation. A plot of the $\gamma$ ray signal with the neutron signal in correlation with the position of the well-logging instrument provides a quantitative indication of the hydrocarbon content. Details of the well-logging instrument are described along with several variations in the method. (M.P.G.)

**6964** SCINTILLATION DETECTION IN WELL LOGGING USING FAST AND SLOW PHOSPHORS. William R. Orr, Jasper E. Richardson, and Emanuel Baskir (to Shell Oil Co.). U. S. Patent 3,116,417. Dec. 31, 1963. Filed Dec. 8, 1959.

An apparatus for nuclear logging of boreholes is described which has a pair spectrometer in compact form. The apparatus comprises a housing, a neutron source, two scintillation detectors, one having a composite phosphor of long and short decay times and the other having a single short-decay-time phosphor, circuit means for separating the pulses from the composite phosphor, a coincidence circuit, and a pulse analyzing and recording system. (D.L.C.)

**6965** TRACER INJECTOR MEANS UTILIZING A RADIOACTIVE ELECTRODE. Philip W. Martin (to McCullough Tool Co.). U. S. Patent 3,116,419. Dec. 31, 1963. Filed Aug. 6, 1959.

An improved method is given for dispensing radioactive tracer deep in a borehole, especially in secondary recovery operations in which water is injected under pressure into the borehole to move oil from depleted fields. The method is safe, requires no radioactive liquids, and is not affected by pressure surges within the borehole. In the method, a solid radioactive electrode is located along with a detector on a sonde in the borehole, and radioactive material is released from the electrode by means of a voltage applied for a short time. (D.L.C.)

## Thorium and Uranium Minerals

**6966** DISTRIBUTION OF URANIUM, THORIUM AND RARE-EARTH ELEMENTS IN GRANITOIDS OF THE SUSAMYR BATHOLITE (CENTRAL TIAN-SHAN). L. L. Leonova and Yu. A. Balashov (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 11, 1008-15(Nov. 1963). (In Russian)

In the batholite rocks (gabbro-granodiorites–leucocratic granites) there is no correlation between U, Th, and TR. In the differentiation process uranium accumulates in the final products (from 1.3 $\gamma$/g to 8.5 $\gamma$/g), thorium somewhat increases from the I phase (13 $\gamma$/g) to the II and further remains on the same level (30 $\gamma$/g). The behavior of $\Sigma$Ce- and $\Sigma$Y-earths in the process of rock differentiation is directly opposite: $\Sigma$Ce in general decreases from rocks of the I phase to vein ailites and $\Sigma$Y increases in the same direction; the content of $\Sigma$TR ($\Sigma$Ce + $\Sigma$Y) is constant in all rocks and is ~400 $\gamma$/g. (auth)

**6967** STUDY OF OXIDATION-REDUCTION PROPERTIES OF SEDIMENTARY URANIFEROUS ROCKS. L. S. Evseeva and N. P. Fomina. Geokhimiya, No. 11, 1050-4 (Nov. 1963). (In Russian)

Oxidation-reduction properties of uraniferous sandstones and rocks of coaly-carbonaceous composition were studied. The relative oxidation-reduction capacity of rocks is established by the mentioned potential being the value of the decrease of the solution-oxidant potential interactions with the rock sample. It is shown that an epigenetic enrichment of sedimentary rocks in uranium, the degree of their uranium content, is directly proportional to the value of the mentioned potential of the rocks. (P.C.H.)

# HEALTH AND SAFETY

**6968** (AE-126) REPORT ON THE PERSONNEL DOSIMETRY AT AB ATOMENERGI DURING 1962. K-A. Edvardsson and S. Hagsgård (Aktiebolaget Atomenergi, Stockholm). Dec. 1963. 12p.

Personnel monitoring activities at atomic energy installations in Sweden and Norway during 1962 are reported. No radiation doses exceeded the recommendations of the ICRP. (C.H.)

**6969** (ANL-6786) ARGONNE NATIONAL LABORATORY RADIOLOGICAL ASSISTANCE TEAM. G. T. Lonergan and W. H. Smith (Argonne National Lab., Ill.). Oct. 1963. Contract W-31-109-eng-38. 37p.

The organization, training, equipment, and operation of a radiological assistance team are described. The team renders assistance in the event of incidents involving radiological safety or weapons incidents. (C.H.)

**6970** (CONF-67-36) RADIATION EXPOSURE INDICES—A METHOD FOR EVALUATING EXPOSURE EXPERIENCE. P. Tedeschi (Argonne National Lab., Ill.). Feb. 1963. Contract [W-31-109-eng-38]. 13p. (UAC-7845)

From Health Physics Society 8th Annual Meeting, New York, June 1963.

Radiation Exposure indices can be used by the Health Physicist to evaluate exposure experience in much the same manner that Safety Engineers evaluate industrial accident experience. The indices used would be Frequency Rate (Number of measurable exposures per $10^6$ monitored manhours), Exposure Rate (mr per hour per exposure), and the Average Exposure (mr per exposure). The advantage of using the exposure indices is that exposure experience can be discussed in reference to whether it is getting better or worse instead of in reference to maximum permissible levels. The exposure indices were applied to personnel exposure data from the Argonne National Laboratory. The results show that in 1959 the Frequency Rate for employees monitored gradually increased. It remained constant in 1960 and began to decline in 1961. The Exposure Rate for employees with measurable exposure declined in 1959 and 1960, but started a gradual rise in 1961 which continued through 1962. The Average Exposure followed the same trend. The Laboratory's performance for the number of exposures per $10^6$ manhours monitored is improving. The Average Exposure and Exposure Rate are gradually increasing in spite of the fact that all exposures are kept below the recommended maximum permissible levels. (auth)

**6971** (IDO-12033) HEALTH AND SAFETY DIVISION ANNUAL PROGRESS REPORT, 1962. Aubrey O. Dodd, ed. (Idaho Operations Office. Health and Safety Div., AEC). 85p.

Data are presented from measurements of radioactivity in air, vegetation, milk, and ground water in the environs of the National Reactor Testing Station during 1962; personnel radiation dosimetry; the servicing of radiation monitoring instruments; waste management at the site; meteorological conditions; administration of a safety program; and training activities in the fields of radiological health and safety. (C.H.)

**6972** (LAMS-2983) IMPACT AND THERMAL TESTS ON TRANSPORT CONTAINERS ICC 2-R AND ICC 6-J. Horace E. Noyes (Los Alamos Scientific Lab., N. Mex.). Oct. 1963. Contract W-7405-eng-36. 13p.

A series of drop and fire tests were conducted on a container designed for shipment of fissile materials by normal transport methods. The container consisted of an internal container for the nuclear material, an external steel drum, and rod spacers welded to the internal container. In use, the drum would be filled with vermiculite, but this was omitted for the tests. The fire tests were conducted in leaded gasoline for 33 min. The drop tests were made at heights of 4 to 30 ft and various angles. In no case was failure observed, and it is concluded that the integrity of the container is proved. (D.L.C.)

**6973** (NP-13432) THE CONTAMINATION OF MILK BY RADIONUCLIDES IN FALLOUT. Carl F. Miller (Stanford Research Inst., Menlo Park, Calif.). Oct. 1963. 37p.

The major parameters that influence the uptake and assimilation of radionuclides in fallout by animals foraging on pastures are discussed. Equations for a radionuclide assimilation model for the cow and for the concentration of radionuclides in milk are presented, and values of the equation parameters for $Sr^{89}$, $Sr^{90}$, $Te^{132}$, and $I^{131}$ are derived from available reported data. The use of the model is illustrated by a computation of the concentrations of $Sr^{89}$, $Sr^{90}$, and $I^{131}$ in milk and the absorbed dose in humans from consumption of the milk following the contamination of pastures by fallout from an assumed 15-MT yield land surface detonation. (auth)

**6974** (RISO-66) TRACER EXPERIMENTS FOR THE EVALUATION OF THE PARTICLE-FILTRATION EFFICIENCY OF INSTALLED ABSOLUTE FILTERS. Hans Flyger (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). July 1963. 12p.

The necessity of controlling the efficiency of installed absolute filters and the importance of a correct choice of prefilters to lighten the load of dust are demonstrated by two examples. The investigations were made by the use of a particle cloud of sodium chloride labeled with radioactive sodium-24. The composition of the test cloud was determined and compared with that of the methylene-blue standard cloud. A comparison was made between the efficiencies of highly efficient glass-paper filters as measured by the D.O.P. test and the test cloud used. (auth)

**6975** (TID-19850) AIR CLEANING STUDIES. DIFFUSION BOARD PROJECT. Summary Progress Report, August 1, 1962–June 30, 1963. Leslie Silverman and Robert A. Gussman (Harvard Univ., Boston). Contract AT (30-1)-841. 26p.

Applications of diffusion board concepts in the development of less costly methods for containment of gaseous and particulate emissions from reactor accidents or releases from other nuclear processes are discussed. In the diffusion board concept, a porous building structure would be erected over the reactor or be included in adjacent reactor building walls in the manner of conventional steel containment vessels. It permits steam and radioactive gases and particulates to be decontaminated during passage through the board and yet relieves the stored energy without pressure buildup. Results are reported from evaluation tests of 0.5-in.-thick mineral diffusion board samples for air flow resistance, particulate removal, and iodine removal. (C.H.)

**6976** (TID-19893) FINAL PROGRESS REPORT [ON BIOCHEMISTRY] FOR PERIOD NOVEMBER 1, 1959–OCTOBER 31, 1963. W. D. Armstrong and Leon Singer

(Minnesota. Univ., Minneapolis). Contract AT(11-1)-838. 33p.

Progress is reported in studies on the removal of $Sr^{85}$ from milk by contacting with bone or other apatite materials in absorption columns. The studies were carried out in an effort to develop a simple feasible method of reducing the radiostrontium content of milk. Results are included from studies on the relative binding of Ca and Sr with blood serum proteins and other substances, the removal of Ca and Sr from circulating fluids in the isolated dog limb, the absorption of Ca and Sr from the isolated intestinal loop of rats, the distribution of $Ca^{45}$ and $Sr^{85}$ in the intestinal contents and gut wall in normal and nephrectomized rats, and the effect of age and dietary status on the intestinal absorption of Ca and Sr. (C.H.)

**6977** (USNRDL-TR-680) FRACTIONATION. III. ESTIMATION OF DEGREE OF FRACTIONATION AND RADIONUCLIDE PARTITION FOR NUCLEAR DEBRIS. E. C. Freiling (Naval Radiological Defense Lab., San Francisco). Sept. 12, 1963. 46p. (AD-423725)

A simplified, semi-theoretical model of fractionation is presented that is suitable for making interim estimates of degree of fractionation and of radionuclide partition between local, intermediate, and worldwide fallout. The principles set forth are applicable to the treatment of air-, tower-, and surface-burst debris (in the order of decreasing confidence) and to correcting fallout-prediction systems for fractionation effects. (auth)

**6978** (AEC-tr-6230) POSSIBILITIES OF PROLONGED GENERATION IN AIR OF IODINE 131 VAPOR FROM THE STANDPOINT OF ITS ADSORPTION BY FRENCH ACTIVATED CARBONS. F. Billard, G. Chevalier, and J. Pradel (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). Translated from report CEA-413. 1962. 26p.

Investigation of activated carbons showed that it is necessary to have a generator which develops iodine for prolonged periods of time in order to determine the applicability of certain theories advanced in regard to the mechanism of adsorption of different forms of iodine radioisotopes. A generator in which sodium iodide is oxidized by a current of air or oxygen at elevated temperatures is described. A modification of this apparatus with a 5 curie source is proposed for checking the performance of a 100,000 $m^3$/hr trap with a purification coefficient of $10^4$, which is to be used in the ventilation circuit of an enclosure surrounding a nuclear reactor. (auth)

**6979** STORAGE OF RADIOACTIVE FISSION PRODUCT SAMPLES. William J. Maeck and James E. Rein (Phillips Petroleum Co., Idaho Falls, Idaho). Anal. Chem., 36: 252-3(Jan. 1964).

To evaluate the storage of dilute fission product solutions, the degree of absorption of 1-day cooled and 1-year cooled fission products was measured for two different media in four container materials over periods of time up to 1 month. The selected media were nitric and hydrochloric acids. Acid concentration was varied over the range of 1 to 10 M. The containers were borosilicate glass, wax-coated glass, Vycor glass, and polyethylene. Borosilicate glass was found to be superior for 1-day cooled fission product solutions. The adsorption of 1-year cooled gamma-emitting fission products was much less than that of young fission products. Polyethylene is the preferred storage material and hydrochloric acid-hydrogen peroxide is a better medium than nitric acid. (P.C.H.)

**6980** HOW FALLOUT AFFECTS THE DAIRY INDUSTRY. J. Chowdhry. Dairy Eng., 80: 374-6, 381(Oct. 1963).

Dairy products and their susceptibility to radioactive contamination in the event of heavy fallout are discussed. Methods of rendering milk safe for human consumption are described. (Public Health Eng. Abstr., 43: Dec. 1963)

**6981** SURVEILLANCE OF RADIOACTIVITY IN WATER. A. Grauby and P. Raimbault. Eau, L., 50: 307-13(May 1963).

Various instruments available for monitoring radioactivity in water are described. The apparatuses may be employed in a fixed position, as a mobile unit, or in a floating station, depending upon the nature of the body of water to be monitored and the source of radiation contamination. (Public Health Eng. Abstr., 43: Dec. 1963)

**6982** DECONTAMINATION OF SURFACES CONTAMINATED WITH RADIOACTIVE DUST. A. Siemaszko and R. Plejewski (Inst. of Nuclear Research, Polish Academy of Sciences. Warsaw). Kernenergie, 6: 561-5(Oct. 1963). (In German)

Experiments were carried out for the decontamination of various materials, which were contaminated with radioactive dust. The vacuum exhaust method as well as the washing method using water or special solutions in combination with simultaneous brushing were used. (tr-auth)

**6983** INCORPORATION CONTROL METHODS FOR OCCUPATIONALLY RADIATION-EXPOSED PERSONS. J. Sommer (Zentralinstitut für Kernphysik. Bereich Radiochemie. Rossendorf. Ger.). Kernenergie, 6: 531-40(Oct. 1963). (In German)

Methods of determining the body burden from incorporated radioisotopes in persons occupationally exposed are discussed. The direct method by part- and whole-body counting and the indirect method by separation analysis are described. (M.C.G.)

**6984** THE $Sr^{90}$ AND $Sr^{89}$ CONTENTS OF GERMAN CHEESE AFTER RESUMPTION OF NUCLEAR TESTS IN THE AUTUMN OF 1961. Adriana E. Marah, O. Paakkola, and E. Knoop. Kiel. Milchwirtsch. Forschber., 15: 33-40 (1963).

Samples of hard cheese made in Schleswig-Holstein and Bavaria from mid-September to mid-November 1961 were tested. The average values of $Sr^{89}$/10 day periods were 9–46 $\mu\mu$C/g Ca for both provinces, the maximum daily value being 64 $\mu\mu$C/g Ca for the former and 68 $\mu\mu$C/g Ca for the latter province. The $Sr^{90}$ levels in the cheese remained virtually constant averaging about 4 $\mu\mu$C/g Ca for Schleswig-Holstein and 6.6 $\mu\mu$C/g Ca for Bavaria. The $Sr^{90}$:Ca ratio of the milk did not differ from that of the cheese. It was concluded from the $Sr^{89}$:$Sr^{90}$ ratios and other considerations that only about 6–10% of $Sr^{90}$ in the milk and cheese originated from the fresh fallout, the remainder resulting from nuclear testing carried out before the autumn of 1958. (Public Health Eng. Abstr., 43: Dec. 1963)

**6985** SAFETY OF NUCLEAR SYSTEMS IN SPACE APPLICATIONS. Charles M. Barnes. Military Med., 128: 766-8(Aug. 1963).

Problems associated with the launch of the first 2 nuclear auxiliary power devices are discussed. (Public Health Eng. Abstr., 43: Dec. 1963)

**6986** MEASUREMENT OF THE RADIATION LOAD IN JET FLIGHT TRAFFIC BY RADIOACTIVE FALLOUT AND BY COSMIC ULTRA RADIATION. O. C. Allkofer and J. Truemper (Institut für Reine und Angewandte Kernphysik, Kiel). Telefunken Ztg., 36: 158-66(July 1963). (In German)

Measurements were made of radiation in jet flights between Frankfurt and New York, San Francisco, and Tokyo. Measurements were made of the radioactivity of the cabin

air using the dust filter method. The radioactive contamination of the outer surface was measured with the help of adhesive films for dust and swab samples. The radiation dose from cosmic radiation was measured with the help of scintillation detectors. Measurements were made February 17 to March 16 and from September 5 to December 2, 1961. Results are shown on graphs. (M.C.G.)

**6987** EVACUATION OF THE INJURED FROM A HEAVILY IRRADIATED BUILDING. Zivilschutz, 26: 306-9(Sept. 1962). (In German)

A description, based on data collected from American technical literature, of the reconnaissance, protective, and rescue measures taken at the Idaho Falls reactor accident January 3, 1961, in which three people died from radiation exposure is presented. Due to the high radiation level (up to 500 r/h), there were numerous difficulties in carrying out these measures; these difficulties were, however, overcome without a single rescuer suffering any radiation damage. Although of limited application, numerous lessons can be drawn from this incident about the availability of protective equipment and measuring instruments, and the training of rescue workers who may be required to work in high levels of radiation. (auth)

**6988** A LARGE VOLUME, CONTINUOUS GAS EFFLUENT MONITORING SYSTEM. Donald E. Feltz (Agricultural and Mechanical Coll., College Station, Tex.). 8p. (CONF-243-40)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

A gaseous effluent monitoring system was developed and installed for continuous monitoring of building exhaust gases. The system provides two channels for continuous gamma photopeak or integral monitoring of gases and is comprised of a 3'' × 3'' NaI (Tl) gamma scintillation detector, a shielded 30-liter volume gas sampler with machined helical insert for gas flow control, an air pumping system, a transistorized dual channel gamma spectrometer, and a multipoint recorder. Linear calibrations of $2.42 \times 10^{-9}$ μc/ml-cpm and $1.21 \times 10^{-9}$ μc/ml-cpm were obtained for the detection of argon-41 gas using photopeak counting and integral counting, respectively. A sensitivity of $6 \times 10^{-8}$ μc/ml corresponding to 25 net counts per minute, which is twice background, was observed for photopeak counting of argon-41. (auth)

# INSTRUMENTATION

## General

*Refer also to abstract 7306.*

**6989** (AD-289031) AFTAC MAGNETIC TAPE RECORDING STANDARDS. PROJECT VELA-UNIFORM. Ben S. Melton (Air Force Technical Applications Center, Washington, D. C.). Oct. 25, 1962. 15p.

Magnetic tape is to be used as a primary recording system for seismic data in VELA-UNIFORM projects. Standards, including basic requirements and time code standards, are given for use in such magnetic-tape recording. (D.L.C.)

**6990** (BLG-189) ETUDE EXPERIMENTALE D'UN OBTURATEUR DE NEUTRONS THERMIQUES. (Experimental Study of a Chopper for Thermal Neutrons). S. Hautecler and W. van Dingenen (Brussels. Centre Belge d'Etude de l'Energie Nucleaire). Nov. 1962. 27p.

The neutron chopper used with the time-of-flight spectrometer at the BR1 reactor to investigate the dynamics of atoms bound in liquids and solids is described, and the results of experimental and theoretical studies of the properties of the chopper are discussed. (D.C.W.)

**6991** (BNL-7470) FAST DECIMAL COUNTING WITH BINARY-DECIMAL LOGIC. V. Radeka (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 11p. (CONF-363-7)

From International Symposium on Plasma Phenomena, San Diego, Calif., Oct. 1963.

The speed limits of decimal counting schemes based on binary-to-decimal conversion are considered. A simple "1-2-4-8" decimal logic is described, which is inherently as fast as the basic bistable. A decade for counting in the 100–200 Mc/sec range, based on this logic and the tunnel diode-transistor bistable, is presented. (auth)

**6992** (KR-57) THE KJELLER AUTOMATIC NEUTRON DIFFRACTOMETER. H. Strand, A. F. Andresen, R. Engevik, and T. Riste (Norway. Institutt for Atomenergi, Kjeller). Sept. 1963. 29p.

An instrument for single crystal structure investigations by neutron diffraction is described. The device can automatically measure the reflected neutron intensities in one zone of reflections. The measurements are performed by step-scanning the diffraction peaks, the crystal moving at half the angular speed of the counter. The instructions for automatic operation are fed to the machine on punched paper tape, and the output data are printed on adding machine tape. (auth)

**6993** (NP-13333) TUNNEL'NYI DIOD PRINTSIP RABOTY I OSNOVY SKHEMNOGO RASCHETA (OBZOR). (Tunnel Diode—Principles of Operation and Bases of Circuit Calculations. (A Review).) I. F. Kolpakov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 88p.

A review is given of the physical principles of tunnel diodes, and quantum mechanical ratios describing the tunnel effect in thin p-n semiconductors are considered. The performance of tunnel diodes under amplification, generation, and switch-over is discussed. Tunnel diode digital techniques and efficiency in fast nuclear electronics are also discussed. 149 references. (R.V.J.)

**6994** (NP-13343) ETUDE ET REALISATION D'UN CONVERTISSEUR TEMPS-AMPLITUDE DIFFERENTIEL POUR LE DOMAINE DES NANOSECONDES (theses). (Study of the Feasibility of a Differential Time-Amplitude Converter for the Nanosecond Region (thesis)). Pierre Blanc (Lyon. Université). [196?]. 40p.

Because of the advantages of the Bay apparatus and of time-amplitude converters, the application of the Bay method to converters working in the nanosecond region was studied. These converters are as sensitive as coincidence devices to the dispersion of amplitudes furnished by the actual detectors. The apparatus resulting from connection to a multichannel analyzer recorder can easily give a distribution of the time intervals between nuclear events. It can be utilized near accelerators because of its mobility, the shielding of its detectors, and the distance that can separate the detectors from the block of the device. It can work in a high particle flux (of the order of $10^4$ pulses/sec). The apparatus performs at least as well as circuits previously described. The linearity and resolution time ($1.5 \times 10^{-11}$ sec) are excellent. The improvements that can be made are indicated. (J.S.R.)

**6995** (TID-19839) DEVELOPMENT OF A FIVE-INCH HIGH-SPEED PHOTOMULTIPLIER. Second Quarterly Report, September 9, 1963 to December 9, 1963. F. A. Helvy (Radio Corp. of America. Electron Tube Div., Lancaster, Penna.). Dec. 10, 1963. Contract AT(30-1)-3190. 7p.

Development is reported of a 5-inch high-speed photomultiplier with small transit time spread, short pulse rise time, uniform collection efficiency over most of the entrance window area, and low dark current. The first tube is expected to be constructed before Jan. 1, 1964. (D.L.C.)

**6996** (TID-19904) DEVELOPMENT OF A PHOTOMULTIPLIER HAVING A PULSE RISE TIME LESS THAN $5 \times 10^{-10}$ SECOND. First Quarterly Report, June 15, 1962–September 15, 1962. (Radio Corp. of America. Electron Tube Div., Lancaster, Penna.). Contract AT(30-1)-3032. 3p.

The electrical design of the input electron-optical system was substantially completed. A variety of mechanical structures for realizing this electrical design was investigated, tests of particular materials for use in these structures began. Design of the anode region and output transmission line was started. Mechanical design of the well-established parts of the tube, such as the multiplier proper, are underway. (auth)

**6997** (TID-19905) DEVELOPMENT OF A PHOTOMULTIPLIER HAVING A PULSE RISE TIME LESS THAN $5 \times 10^{-10}$ SECOND. Second Quarterly Report, September 15, 1962–December 15, 1962. (Radio Corp. of America. Electron Tube Div., Lancaster, Penna.). Contract AT(30-1)-3032. 4p.

The electrical and mechanical designs (described) are complete, and all parts and fixtures are either finished or on order. A voltage divider was constructed to test the first tube when complete. (auth)

**6998** (TID-19906) DEVELOPMENT OF A PHOTOMULTIPLIER HAVING A PULSE RISE TIME LESS THAN $5 \times 10^{-10}$ SECOND. Third Quarterly Report, December 15, 1962–March 15, 1963. (Radio Corp. of America. Electron Tube Div., Lancaster, Penna.). Mar. 18, 1963. Contract AT(30-1)-3032. 7p.

Seven tubes were made, the first three of which went to air because of leaky seals. Electrical static and pulse

testing was initiated and led to some improvements in the tubes. (D.C.W.)

**6999** (TID-19907) DEVELOPMENT OF A PHOTOMULTIPLIER HAVING A PULSE RISE TIME LESS THAN $5 \times 10^{-10}$ SECOND. Final Report, June 15, 1962 to June 14, 1963. F. A. Helvy (Radio Corp. of America. Electron Tube Div., Lancaster, Penna.). Contract AT(30-1)-3032. 70p.

Twenty-two of the fourteen-stage side-window photomultipliers were constructed. The design, fabrication, and electrical testing (pulsed and static) of the tubes are described. The test results and drawings of the tube parts are included. (D.C.W.)

**7000** (UCRL-7567) TRANSISTORIZED 10-Mc DECADE SCALER. C. A. Van Den Heuvel (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 24, 1963. Contract W-7405-eng-48. 21p. (CONF-363-11)

From American Ceramic Society Basic Science Division Meeting, Washington, D. C., Oct. 1963.

A space-saving, standard, transistorized 10-Mc decade scaler of modular construction was developed to replace assorted earlier types of scalers. For high reliability, silicon planar transistors are used throughout, except for readout drivers. Two complete scalers are contained in a standard, rack mounting frame of $3\frac{1}{2}$-inch front panel height. A power supply module on the rear panel powers both scalers. Each scaler comprises nine modules. One module contains a tunnel diode pulse height discriminator with a threshold variable from 0.1 to 2 volts, and temperature coefficient less than 1 mv/°C. Another module contains a diode gate for gating the discriminator output, and the reset circuitry for the scaler modules. A third module contains a 10-Mc decade counting unit (DCU). Six identical 1-Mc DCU's complete the scaler. Ten-digit front panel readout of the DCU's is provided by neon lights in column configuration. External DCU readout is provided by four-line binary-coded decimal signals in 1-2-4-8 code. (auth)

**7001** X-RAY SPECTROPHOTOMETRY IN VIVO. Bertil Jacobson (Karolinska Institutet, Stockholm). Am. J. Roentgenol., Radium Therapy Nucl. Med., 91: 202-10(Jan. 1964).

The main disadvantage of the x-ray spectrophotometric method is the limited intensity of the monochromatic x rays. This is a particularly difficult problem in iodine analysis when objects more than 10-cm thick can be examined to only a low degree of accuracy. In bone salt analysis the low intensities make it difficult to use a third fat wedge, and, as pointed out above, this incurs a systematic error. Hence, further development of the technique is indicated. The chief advantage of the method of quantitative analysis in vivo is that it provides a means of solving certain problems. The technique has application in any situation in which pathologic conditions result in changes in the elementary composition in the body, or when such changes can be produced artificially, for instance by means of roentgenographic contrast media. The method is rapid, a complete quantitative analysis in vivo or in vitro requiring only a few seconds, and no preparation of the test sample is necessary. Another important advantage is that the radiation dose to the patient is kept close to a theoretical minimum. (auth)

**7002** THE USE OF 90 kv X-RAY GENERATORS AS A RADIATION SOURCE. B. Coleby, A. J. Bailey, and D. N. Rhodes (Low Temperature Research Station, Cambridge, Eng.). Intern. J. Appl. Radiation Isotopes, 14: 499-502 (Nov. 1963).

Standard crystallographic x-ray generators were modified for use as laboratory radiation sources. Average dose rates of 8000 rad/min were obtained in a volume of 35 ml and 400 rad/min in 140 ml by employing double-sided irradiation. The unfiltered radiation gave a half-value depth in tissue of 2.4 mm and was considered unsatisfactory for surface irradiation treatment of fruit. (auth)

**7003** PROPOSAL FOR THE SYSTEMATIC CLASSIFICATION OF RADIOACTIVE THICKNESS AND DENSITY GAUGES. H. Hart and E. Schurz (Forschungsstelle für Technische Gasentladungen, Potsdam, Ger. and VEB Vakutronik WIB, Dresden). Kernenergie, 6: 565-74(Oct. 1963). (In German)

Proposals are made for a classification of the different industrial instruments using nuclear radiation for measurement. Thickness-measurement instruments are described. The possible viewpoints are listed, from which a classification of the instruments can be made. The types of instruments are separated according to their physical measuring principles and some secondary classification points (detector, electronic measuring principles) are discussed and presented schematically. Some proposals for possible type designations based on the scheme described were derived. (tr-auth)

**7004** THE PHYSICAL AND GEOMETRIC PROPERTIES OF THE MEASURING OBJECT AS CRITERION FOR THE DETERMINATION OF PARAMETERS OF A RADIOACTIVE RELAY. J. Czarnecki. Kernenergie, 6: 575-7 (Oct. 1963). (In German)

For the radiation relay working without hysteresis, a method for determination of parameters is given, in which the properties of the measuring object serve as starting points. A general formula was derived, in which the parameters of the measuring object and the requirements for accuracy and speed in the results of the measuring and standardization processes were considered. It is shown that these quantities plainly determine the data for the electronic wiring. In the roll of the zero effect it was indicated that its influence on determination of certain parameters is comprehended mathematically. On the basis of the derived formula, the determination of the least possible activity for a given work period and a required reliability is possible. For the discussion of the dynamic state it is assumed that the change of the pulse density by the measuring object is not discontinuous but occurs continuously. The derived relation can be used for calculation of portable filled measuring apparatus. (tr-auth)

**7005** A FAST BIDIRECTIONAL DECADE COUNTING SYSTEM. L. Bondár (Technische Hochschule, Aaechen). Nucl. Instr. Methods, 24: 280-4(Sept. 1963).

The electronic part of a digital measuring apparatus for the analysis of bubble chamber photographs or nuclear emulsion events is described. The system is adapted for on-the-fly printout of the data on punched tape. Bidirectional counting speeds of $10^5$ cps are attained. (auth)

**7006** ABOUT A SIMPLE TIME-TO-PULSE-HEIGHT CONVERTER. G. A. Grin and C. Joseph (Université, Lausanne, Switzerland). Nucl. Instr. Methods, 24: 331-2 (Sept. 1963).

A three-diode nsec-range time-to-pulse-height converter is described. The converter has linearity better than 1%, and a thermal coefficient smaller than 0.03%/°K below 40°C. (T.F.H.)

**7007** ABERRATIONS IN ELECTROSTATIC QUADRUPOLES. D. Orr (Makerere University Coll., Kampala, Uganda, East Africa). Nucl. Instr. Methods, 24: 377-80 (Oct. 1963).

Measurements were made with a single electrostatic quadrupole and spherical aberration noted. Partial correction of this aberration was effected by utilizing a laminated quadrupole, which allows the voltage distribution along the axial length of the quadrupole to be varied. (auth)

**7008** TIME TO AMPLITUDE CONVERTER. Zbigniew Hoffman and Aleksander Sawicki (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 209-12(1963). (In Polish)

Two time-to-amplitude converters were built for use with a 100-channel pulse-height analyzer, one for thermal neutrons and the other for resonance neutrons. The latter is described in detail. The two are basically the same except for the slope of the time-to-pulse-height ramp and the range of variable analog delay circuits. The resonance-neutron circuit has a stepwise-variable ramp whose length can be selected as 100, 200, or 400 μsec duration. The energy range of neutrons analyzed can be selected with the proper choice of ramp duration and initial delay. This delay is continuously variable from 50 to 5000 μsec. The stability in terms of channel width (in time) and in linearity of converting time to pulse height is given as better than 1%. (TTT)

**7009** AN AMPLIFIER FOR NSEC PULSES WITH TRANSISTORS. H. Paucksch. Telefunken Ztg., 36: 173-8(July 1963). (In German)

A transistorized instrument was developed for amplification of nanosecond pulses. Diagrams and pictures are shown. Estimation of bandwidth and number of stages, standardization of the bandwidth for the individual stages, measures for obtaining the predicted initial voltage, and wiring for stabilization of the work point are discussed. (M.C.G.)

**7010** AN ULTRA-HIGH VACUUM BEAM CHOPPER. P. E. McElligott, R. W. Roberts, and G. Jernakoff (General Electric Research Lab., Schenectady, N. Y.). Vacuum, 13: 419-20(Oct. 1963).

The construction and operation of a small mechanical modulator for molecular beams are described. This device consists of a vibrating reed that is magnetically driven at its resonant frequency. There is a minimum of moving parts, and the associated electrical circuitry is extremely simple. The modulator is constructed from materials with low vapor pressures and is well-suited to operation in ultra-high vacuum ($\sim 10^{-10}$ torr). (auth)

**7011** IONIZATION GAGE OF THE BAYARD-ALPERT TYPE. A. M. Shroff (Compagnie Générale de Télégraphie sans Fil, Orsay, France). Vide, 18: 460-5(Sept.-Oct. 1963). (In French)

The theory, design, calibration, and operating characteristics of an ion gage for measuring pressures down to 100 ptorr are given. The gage has a central collector. (T.F.H.)

**7012** PLASMA PROBE INSTRUMENTATION OF EXPLORER X. H. S. Bridge, A. J. Lazarus, E. F. Lyon, B. Rossi, and F. Scherb (Massachusetts Inst. of Technology, Cambridge). p.1113-1121 of "Space Research. III." New York, Interscience Publishers, 1963.

A Faraday cup with plane grids was used as a large solid-angle detector of low-energy protons. A pulsating retarding voltage applied to one grid allowed a measurement of the flux of those protons whose energies were below a specified value, which was varied in six steps up to a maximum of 2,300 ev. A bias voltage applied to another grid repelled plasma electrons and suppressed spurious signals due to photoelectric emission. The pulsating signals from the cup passed through a compression amplifier, were detected, and were telemetered in real time to the earth. The effective area of the detector was 18 $cm^2$ and the dynamic range of the entire system allowed measurements from $6 \times 10^6$ to $6 \times 10^{10}$ particles/$cm^2$ sec. Due to the rotation of the vehicle, the shape of the reconstructed signal as a function of time gave information on the arrival direction of the protons. The plasma probe equipment consumed a steady power of 20 milliwatts plus 20 milliwatts based on a 3% duty cycle. The total mass of the Faraday cup and electronics was 1.2 kilograms, excluding the telemetry. (auth)

**7013** ELECTRONIC SOLAR FLARE ALARM SYSTEM. N. Gutlove and S. Morrison (Republic Aviation Corp., Farmingdale, N. Y.). Paper 1.3.2 of "Technical Papers." North Hollywood, Calif., Western Periodicals Co., 1963. 15p.

The work done in designing and breadboarding a solar flare alarm system employing video digital techniques is described. The conceptual design of the system is presented, and experimental apparatus, solar and flare simulation equipment, and procedures employed in obtaining performance data are described. Experimental measurements and results are included. In general, it was found that the system is capable of detecting simulated flares whose contrast exceeds that of the immediate solar background by a factor of 1.5 to 2.0. Positional linearity in determining the precise location of the flare on the solar disc is within ±2.5%. Spurious signal generation in the system due to vidicon amplifier noise and noise in the counter circuitry was found to be less of a problem than was anticipated. (auth)

**7014** MICROELECTRONIC DEVICES FOR APPLICATION IN TRANSIENT NUCLEAR RADIATION ENVIRONMENTS. R. W. Marshall (Hughes Aircraft Co., Fullerton, Calif.). Paper 1.4.1 of "Technical Papers." North Hollywood Calif., Western Periodicals Co., 1963. 6p.

The results of environmental tests designed to determine the relative susceptibility of monolithic silicon and thin film integrated circuits and devices to the transient nuclear radiation environment associated with a nuclear explosion are discussed. These results strongly indicate that hybrid thin film circuits employing high frequency transistors should be used in systems that require microelectronic circuitry to operate in a transient radiation environment. Tests conducted on experimental devices indicate that the insulated-gate thin-film field effect transistor is less affected by transient nuclear radiation than any other active microelectronic device presently available. When the insulated-gate field effect device becomes commercially available, it should provide complete thin film integrated circuits that are highly resistant to transient nuclear radiation. (auth)

**7015** AN ESTIMATE OF RADIATION EFFECTS ON ELECTRONIC COMPONENTS FOR THE LUNAR EXCURSION MODULE. D. A. Gandolfo and J. J. Stekert (RCA Applied Research, Camden, N. J.). Paper 1.4.3 of "Technical Papers." North Hollywood, Calif., Western Periodicals Co., 1963. 11p.

The various radiation sources (solar flares and natural and artificial Van Allen Belts) to be encountered on the Apollo Mission were compared with regard to effect on electronic components. It is found that a large class 3+ flare constitutes the most serious hazard. It is assumed that such a flare will occur and the degradation in performance of electronic components caused thereby, is calculated. Resistors and capacitors are unaffected but

transistors are seriously affected. Unshielded 50 mc Si and 10 mc Ge transistors will experience gain reduction to 70% of initial; transistors of lower cutoff frequency will experience a proportionately greater reduction. A one gm/cm$^2$ Al shield reduces the damage by a factor of 4 in Si and 5 in Ge transistors. (auth)

**7016** SELECTION OF RADIATION QUALIFIED SEMICONDUCTOR ELECTRONICS FOR SPACE SYSTEM DESIGN. R. R. Brown (Boeing Co., Seattle). Paper 1.4.4 of "Technical Papers." North Hollywood Calif., Western Periodicals Co., 1963. 7p.

Factors controlling the evaluation of radiation vulnerability of transistors, diodes, and solar cells are reviewed. Typical results from computer analysis of transistor current gain degradation are presented, emphasizing dependence of degradation on d-c operating point. Particle equivalence for permanent radiation damage in semiconductor devices is summarized. Extension of operational lifetime of space system electronics is also discussed. (auth)

**7017** A NUCLEAR RADIATION RESISTANT CONTROL MOMENT GYROSCOPE. Jack W. Ho (Lockheed Missiles and Space Co., Sunnyvale, Calif.) and Richard F. Cimera. Paper 1.4.5 of "Technical Papers." North Hollywood, Calif., Western Periodicals Co., 1963. 8p.

The nuclear radiation resistant control moment gyroscope is a sensing and control device intended for service in space vehicles with nuclear radiation environment. Its main function is to control the altitude and stability of a spacecraft in orbit. The nuclear radiation resistance is achieved through the highly selective use of radiation resistant materials in the design. One such gyro was ground tested in a nuclear radiation environment. (auth)

**7018** ENVIRONMENTAL RESISTANCE EVALUATION THROUGH ANALYTICAL SIMULATION. I. Doshay (Space-General Corp., El Monte, Calif.). Paper 3.6.2 of "Technical Papers." North Hollywood, Calif., Western Periodicals Co., 1963. 15p.

Analytical simulation through a computer program is used for incorporating in design procedures the actual or predicted environmental resistances of aerospace equipment. Through prior environmental testing, the relation between component parameters and environmental levels may be established. Data may also be analyzed through statistical methods or by physical considerations and resulting parametric relations. By utilizing the statistical and parametric models of component-environment relation in connection with analog design analysis methods, environmental factors can be included in design considerations. This analog model was chosen as a center for the ERIE methodology. For the purpose of demonstrating the feasibility of the design system a fine altitude control system in a polar orbit through the outer Van Allen belt was chosen. Data for analysis of the nominal system were obtained with an IBM 7094 digital computer. Environmental effects on operating parameters are similarly being obtained by digital computer analysis. Evaluation of environmental effects completed to date, as well as analog computer runs on the nominal system, show great promise of this technique to minimize costs of systems testing and to accelerate space programs. (auth)

**7019** IMPROVEMENTS IN OR RELATING TO LOGARITHMIC AMPLIFIERS. Donald Harrison (to United Kingdom Atomic Energy Authority). British Patent 944,106. Dec. 11, 1963. Filed Oct. 18, 1960.

A logarithmic amplifier with negative feedback is designed for use in a reactor power meter, using the output current from an ionization chamber. In the amplifier, the thermionic diode as the logarithmic element is connected in the negative feedback loop with a balancing diode whose bias current is controlled by another amplifier to maintain the balance diode current constant for input current variations over the full logarithmic range of the diodes. (D.L.C.)

**7020** IMPROVED VARIABLE-ENERGY RADIATION DEVICE. Arthur Abbey (to Industrial Nucleonics Corp.). British Patent 944,849. Dec. 18, 1963. Filed Feb. 23, 1961.

A device is designed for providing at a given point radiation of continuously variable energy for measurements of thickness, weight, density, area, and other physical properties of various materials. The device comprises a source of primary beta radiation, target means movably mounted between the source and the point and being formed of plural materials having different atomic numbers, and means for selectively positioning the materials between the source and the point so that they act as a secondary generator of radiation of a characteristic average energy. (D.L.C.)

**7021** IMPROVEMENTS IN OR RELATING TO A METHOD OF AND MEANS FOR MEASURING THICKNESSES OF DEPOSITS. Jean-Claude Tanguy (to Commissariat a l'Energie Atomique). British Patent 945,046. Dec. 18, 1963. Priority date Sept. 8, 1960, France.

A device for measuring the thickness of metallic deposits by beta irradiation and detection of the resulting characteristic x-ray emission is designed which can be used on deposits of light metals. In this device, the sample to be irradiated is connected directly through a nonmagnetic tube with the proportional chamber, and the parasitic retrodiffused beta rays are eliminated by a magnetic field. (D.L.C.)

**7022** IMPROVEMENTS IN SEQUENTIAL SWITCHING DEVICES. Henri Georges Guillon (to Commissariat a l'Energie Atomique). British Patent 945,867. Jan. 8, 1964. Priority date May 12, 1961, France.

A device was designed, which, in response to a trigger pulse, undergoes a sequence of switchings. The device consists of at least one multistage electronic switch with an input and more than two outputs. A different output provides in each case a signal of the switch and trigger pulses applied (in operation) to the input serving to change the switch successively from one state to the next. A means for deriving output pulses occurring at the commencement of the respective signals provided at these outputs is coupled to selected outputs. A mixer with at least two inputs is provided and at least one delay unit is used to delay the output pulses prior to their application as trigger pulses to the switch input. (M.C.G.)

**7023** X-RAY SPECTROSCOPIC SYSTEM COMPRISING PLURAL SOURCES, FILTERS, FLUORESCENT RADIATORS, AND COMPARATIVE DETECTORS. Luis W. Alvarez (to Radiation Counter Labs., Inc.). U. S. Patent 3,114,832. Dec. 17, 1963. Filed July 28, 1960.

An x-ray spectroscopic system for determining the presence of a particular element in a body of matter is patented. The determination can be made quickly and reliably without altering the body. X rays of 2 different wavelengths are used, one slightly longer and one slightly shorter than the wavelength of an absorption edge of the element to be determined. The x-ray wavelengths must also lie between the corresponding absorption edges of the next higher and next lower elements in atomic number. The element to be determined will absorb a larger proportion of the shorter wavelength, while all the other elements will absorb a larger proportion of the longer wavelength. The apparatus can be adjusted so that the intensities of the

x rays transmitted through the body are approximately equal in the absence of the element to be determined. The measurements will remain nearly equal regardless of the attenuation of the x rays, except in the presence of the element to be determined. Details of the design of the apparatus are described and diagrammed. (M.P.G.)

**7024** ION SOURCE FOR MASS SPECTROMETER. Kurt Bruennée (to Atlas-Werke Aktiengesellschaft). U. S. Patent 3,115,591. Dec. 24, 1963. Priority date June 22, 1959, Germany.

An ion source that can produce ions from low-vapor-pressure samples, high-vapor-pressure samples, or mixtures either independently or simultaneously is patented. The casing for the ion source has a pair of hollow double-walled sides connected by a flat bottom wall containing an outlet slit. One hollow wall contains a cathode, and the other wall contains an anode and electron trap. Sample gases to be ionized are introduced into a removable ionization chamber between the hollow walls. Apertures in the walls of the casing and removable chamber are aligned so that electrons can be accelerated from the cathode to the anode and ionize the gases in the removable chamber by electronic collision. The ions pass through outlet slits in the bottom of the chamber and casing. The removable chamber also contains two pairs of electrodes for thermal ionization of low-vapor-pressure samples. The thermal electrode system can be used simultaneously with or independently of the electrode system in the casing walls. The thermal ion source may be replaced by removing the ionization chamber. Use of an air lock with the mass spectrometer permits the chamber to be removed or replaced without loss of vacuum. (M.P.G.)

## Radiation Detection

*Refer also to abstracts 6717, 7339, and 7853.*

**7025** (AED-C-06-09) AUSGEWÄHLTES SCHRIFTTUM NACH SACHGEBIETEN. MESSINSTRUMENTE UND MESSVERFAHREN DER KERNPHYSIK. BIBLIOGRAPHISCHE ZUSAMMENSTELLUNG. (Selected Literature According to Subject Field. Measuring Instruments and Methods of Nuclear Physics. Bibliographic Compilation). Klaus Debertin, comp. (Johann-Wolfgang-Goethe-Universität, Frankfurt am Main. Institut für Kernphysik). Nov. 1963. 149p.

Five hundred and fifty references on measuring instruments and measuring methods applied in nuclear physics basic research are presented. The period Jan. 1962 to June 1963 is covered. Report number, patent number, author, and subject indexes are included. (M.C.G.)

**7026** (AEEW-R-217) A COMPARISON OF THE PREDICTED AND OBSERVED REACTION RATES OF VARIOUS NEUTRON DETECTORS IN A THERMAL REACTOR SPECTRUM. J. P. Hardiman and E. J. Maunders (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Aug. 1963. 31p.

A number of the detectors commonly used in integral neutron spectrum measurements were irradiated in the pitch moderator position of a Calder Hall lattice where the detailed energy spectrum was known from time-of-flight measurements. Predicted and observed reaction rates are generally in good agreement although they are brought into better agreement by a small modification to the spectrum. The predicted cadmium ratios are quite sensitive to the value adopted for the effective cadmium cut off energy, values of which were determined for various detectors using the Ferranti Mercury computer. The values varied over a wide range, although in every case only 40-mil cadmium filters were used. (auth)

**7027** (AERE-R-3073) THE G VALUE AND THE REPRODUCIBILITY OF THE FERROUS-FERRIC DOSIMETER. B. Whittaker (United Kingdom Atomic Energy Authority. Research Group. Wantage Research Lab., Wantage, Berks, England). Oct. 1963. 16p.

Experimental work was carried out to estimate the overall reproducibility of the ferrous sulfate method of radiation dosimetry. The work was divided equally between two separate laboratories using different spectrophotometers. It was shown that the ferric extinction coefficients for the two instruments differed by 2.3%. Correcting for the difference in extinction coefficients, it was shown that the overall reproducibility was ±2% in an experiment involving 128 dosimeters, eight different ferrous solutions, and four separate irradiations at temperatures in the range 16.8 to 31.0°C. Ferric radiation yield (G) values were determined using calorimetric techniques. Isothermal calorimeters were employed, the absorbers being of graphite or aluminum so as to avoid errors due to chemical energy losses. The resulting values of G ranged from 14.8 ± 0.1 to 15.4 ± 0.1. Possible sources of error in the graphite calorimeter are discussed. The G value results are shown to depend to some extent on the nature and internal dimensions of the ampoules used to contain the ferrous solutions. (auth)

**7028** (BNL-7393) FUTURE TRENDS IN DETECTION TECHNIQUES AT SUPER HIGH ENERGIES. Luke C. L. Yuan (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 18p. (CONF-114-22)

From the International Conference on High Energy Accelerators, Dubna, U.S.S.R., Aug. 1963.

The future of bubble chambers, spark chambers, and several counter systems is discussed on the basis of foreseen requirements and current developments in the high-energy field. (D.C.W.)

**7029** (BNL-7479) CONSIDERATIONS ON THE MAGNET FOR THE 80'' HYDROGEN BUBBLE CHAMBER. R. P. Shutt (Brookhaven National Lab., Upton, N. Y.). Mar. 9, 1959. Contract AT-30-2-GEN-16. 26p.

Approximate calculations determining the amounts of copper and iron required for the magnet that will produce the magnetic field for momentum measurements are summarized. (D.C.W.)

**7030** (BNL-7480) 80'' CHAMBER—LOW ENERGY BEAMS. R. R. Rau (Brookhaven National Lab., Upton, N. Y.). May 1, 1959. Contract AT-30-2-GEN-16. 7p.

The advantages and disadvantages of using horizontal and vertical magnetic fields in bubble chambers are discussed. Trajectory calculations for the 80-inch chamber are used to illustrate the problems associated with slow beams that are to be stopped in a chamber with a horizontal field. (D.C.W.)

**7031** (BNL-7487) HYDROGEN REFRIGERATOR DESIGN CAPACITY FOR 80" CHAMBER. J. A. Bamberger, D. P. Brown, and J. E. Jensen (Brookhaven National Lab., Upton, N. Y.). May 25, 1962. Contract [AT(30-2)-Gen-16]. 8p.

The dynamic load at a cycling load of 60 cpm is estimated to be 1830 watts. This dynamic load, plus an estimated static load of 250 watts, adds up to a minimum design load of 2080 watts. (D.L.C.)

**7032** (BNL-7489) FINAL COATHANGER DESIGN. S. Yamamoto (Brookhaven National Lab., Upton, N. Y.).

Nov. 1961, Revised Sept. 25, 1963. Contract [AT(30-2)-Gen-16]. 8p.

Calculated specifications and tolerances are given for coathangers to be made of optical acrylic for a bubble chamber. The relation of the coathangers to the light source is discussed. (D.L.C.)

**7033** (BNL-7490) 80'' BUBBLE CHAMBER EXPANSION SYSTEM. SUMMARY OF PISTON MOTION STUDIES, OCTOBER–NOVEMBER 1962. C. L. Goodzeit (Brookhaven National Lab., Upton, N. Y.). Contract [AT(30-2)-Gen-16]. 19p.

Prior to assembly into the bubble chamber, the expansion system was subjected to two tests to check piston dynamics and reliability of the various components. The piston dynamics results confirmed theoretical predictions. Trouble areas that were encountered and steps taken to remedy them are described: plumbing failures, boot failures, loose objects in system, piston ring abrasion, and piston failure. (D.L.C.)

**7034** (BNL-7491) MAGNET COILS DETAILED CONDUCTOR DESIGN. B. B. Culwick (Brookhaven National Lab., Upton, N. Y.). May 6, 1960. Contract [AT(30-2)-Gen-16]. 8p.

The design of the two exciting coils for the 80-inch bubble chamber is considered in some detail. It was decided to design the coils with equal heights and equal current densities. The required cooling and coil dimensions are calculated. The other parameters are tabulated. (D.L.C.)

**7035** (BNL-7492) GENERAL DESCRIPTION OF THE 80'' BUBBLE CHAMBER REFRIGERATION SYSTEM. J. A. Bamberger, D. P. Brown, and J. E. Jensen (Brookhaven National Lab., Upton, N. Y.). May 22, 1962. Contract [AT(30-2)-Gen-16]. 13p.

The reliability and capacity of the refrigeration systems are discussed. The hydrogen and nitrogen systems are described and design specifications are given. The expansion system purifier, control systems, and gas analysis are considered. (D.L.C.)

**7036** (BNL-7493) 80'' BUBBLE CHAMBER EXPANSION SYSTEM. PRELIMINARY OPERATING PROCEDURES. C. L. Goodzeit (Brookhaven National Lab., Upton, N. Y.). Apr. 11, 1963. Contract [AT(30-2)-Gen-16]. 54p.

Procedures are presented for the initial operation of the expansion system and for use as a basis for more complete procedures. The procedures cover the following: initial evacuation and purging of the system with hydrogen, setting up operating pressures on the floor control panel, filling valves and reservoirs to operating pressure, filling chamber, buffer volume, and cylinder head to operating pressure, shutting down the system, disassembling the boot valves during operation, disassembling the solenoid valves during operation, and initial operation. (D.L.C.)

**7037** (BNL-7494) EVALUATION OF MULTI-LAYER INSULATION. D. Brown (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract [AT(30-2)-Gen-16]. 4p.

The advantages and disadvantages of multi-layer insulation for insulating the 80-inch liquid hydrogen bubble chamber are compared with these of liquid nitrogen shielding. The fabrication and costs of the insulation are considered briefly. (D.L.C.)

**7038** (BNL-7495) DESIGN CONSIDERATION FOR 80'' BUBBLE CHAMBER. D. A. Kassner (Brookhaven National Lab., Upton, N. Y.). May 11, 1960. Contract [AT (30-2)-Gen-16]. 12p.

A brief description is given of the theory and operation of a bubble chamber. Design considerations are given for the magnet iron and vacuum chamber of the 80-inch bubble chamber. (D.L.C.)

**7039** (BNL-7496) COOL-DOWN REFRIGERATION REQUIREMENTS FOR 80" BUBBLE CHAMBER. J. A. Bamberger (Brookhaven National Lab., Upton, N. Y.). Jan. 25, 1960. Contract [AT(30-2)-Gen-16]. 13p.

Calculations are made of the refrigeration capacity required to cool down the 80-inch bubble chamber from ambient temperature to liquid $H_2$ temperature. The maximum heat flux through the glass to limit glass stress to 1000 psi is found to be 588 watts. The cool-down period is estimated to be 70 hr from ambient to $N_2$ temperature and 6 hr from $N_2$ to $H_2$ temperature, taking surface gradients into account. The required refrigeration capacity is found to be 6500 watts from ambient to $N_2$ temperature and 3350 watts from $N_2$ to $H_2$ temperature. Consumptions of liquid $N_2$ and $H_2$ for cooling by latent heat are also calculated. (D.L.C.)

**7040** (BNL-7497) SOME CONSIDERATIONS ON THE CONFIGURATION AND STABILITY OF THE $H_2$ TEMPERATURE CONTROL LOOPS OF THE 80" BUBBLE CHAMBER. John G. Androulakis (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract [AT(30-2)-Gen-16]. 26p.

A qualitative analysis is given of the temperature-control feedback loops configuration and stability. (D.L.C.)

**7041** (BNL-7498) GENERAL OPERATION AND CONSTRUCTION FEATURES OF THE UNDERCARRIAGE SYSTEM FOR THE 80-INCH BUBBLE CHAMBER. D. H. Wright (Brookhaven National Lab., Upton, N. Y.). Feb. 19, 1960. Contract [AT(30-2)-Gen-16]. 6p.

The undercarriage system is used to position accurately the 450 ton magnet and bubble chamber assemblies in the experimental proton beam of the synchrotron. The operations for translating, rotating, raising and lowering, and separating the magnet sections are described. Load distribution on the wheels and tracking of the machine are discussed. (D.L.C.)

**7042** (CONF-340-4) NaI · Tl AS AN ELECTRON DETECTOR IN A $\beta$-SPECTROMETER. M. S. Freedman, F. T. Porter, I. S. Sherman, and F. Wagner, Jr. (Argonne National Lab., Ill.). [1962]. Contract [W-31-109-eng-38]. 8p.

From American Physical Society 1963 Autumn Meeting, Chicago, Oct. 1963.

The specific response (peak pulse amplitude/kev) vs. electron energy was studied for a cleaved NaI · Tl scintillator disc (18 mm × 2 mm) in a magnetic $\beta$ spectrometer, from 6 to 1000 kev. The response agrees qualitatively with that deduced from gamma-ray data. No reflector covering foil was used, and the light was collected from the cylindrical surface of the disc with a shaped lucite doughnut ring surrounding the crystal, which was mounted directly on the photomultiplier (BMI-9536S) cathode face. Pulse amplitude distributions and backscattering as a function of angle of incidence were studied. Several delayed response states ($T_{\frac{1}{2}}$ = ~300 $\mu$sec, ~8 msec, ~1 minute, at 25°C) were observed. Problems relating to its use as a wide range, high efficiency (>90% at 6 kev) electron detector in a $\beta$ spectrometer are discussed, particularly with respect to the background due to the long-lived traps. (auth)

**7043** (CONF-340-5) THE ARGONNE DOUBLE ELECTRON COINCIDENCE $\beta$-SPECTROMETER. F. Wagner, Jr., F. T. Porter, and M. S. Freedman (Argonne National Lab., Ill.). [nd]. Contract W-31-109-eng-38. 8p.

From American Physical Society 1963 Autumn Meeting, Chicago, Oct. 1963.

An iron-free toroidal $\beta$-coincidence spectrometer was

constructed which was designed for high transmission and luminosity and fairly high resolution. The spectrometer comprises two 100-gap Kofoed-Hansen spectrometers mounted coaxially in a common vacuum chamber. Its performance is described and compared with that of the Chalk River spectrometer. (D.L.C.)

**7044** (HW-79186) RADIOLOGICAL MONITOR FOR THE COLUMBIA RIVER. J. L. Stringer (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1963. Contract AT(45-1)-1350. 29p.

The radiological monitoring system measures gamma dose rates from continuously pumped samples of the Columbia River at Hanford. The system includes a scintillation detector, stable and reliable circuitry, recording instrumentation, and both on-station and remote alarm signaling circuitry. The system has linear measurement ranges of 0 to 8 $\mu$r/hr, 0 to 100 $\mu$r/hr, and 0 to 1300 $\mu$r/hr (calibrated with $Ra^{226}$). The instrumentation is contained in a small building which provides a control of temperature of 75 ± 15°F. Measurements on the complete detection and electronics portion of the monitor showed that a – 6% of full scale change occurred in the 0 to 100 $\mu$r/hr range for temperature change from 50 to 115°F. Errors in all ranges were negligible over the controlled temperature range of 75 ± 15°F. These temperature stabilities were made possible by a discriminator circuit which provided system measurement for photons exceeding 0.1 Mev. The monitor system alarm circuitry provides local and remote, visual and aural signaling. Above-normal dose rates, monitor failure giving a zero reading, and power system failure will cause a system alarm. Following restoration of line power after an outage, the system will automatically reenergize itself and the primary water pump. The emergency water-sampling equipment used with the original monitor was modified and retained in the final system. This equipment will obtain a direct water sample for laboratory analysis whenever above-normal dose rates occur. The complete monitoring system has now operated successfully for 14 months. (auth)

**7045** (JINR-E-1426) FERRITE-CORE INTERMEDIATE MEMORY FOR HANDLING INFORMATION PRESENTED BY RADIATION DETECTOR SYSTEMS. Bela Sebestyen (Shebesht'en) (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 17p. (CONF-369-1)

From International Symposium on Nuclear Electronics, Paris, Nov. 1963.

A transistorized ferrite-core intermediate memory, suitable for storing information from radiation detectors, is described. The coded information from the memory is transferred onto punched paper tape for further study with digital computers. The capacity of the memory is 120 words of 48 bits. The resolution time is 10 $\mu$sec. There is a build-in control system and a cathode ray oscilloscope in the memory for testing its operation. (auth)

**7046** (JINR-P-1437) NANOSEKUNDNAYA MNOGOKRATNAYA SKEMA SOVPADENII I ANTISOVPADENII NA TUNNEL'NYKH DIODAKH I TRANZISTORAKH. (Nanosecond Multiple Coincidence and Anticoincidence Circuit on Tunnel Diodes and Transistors). A. F. Dunaitsev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 14p.

A multi-coincidence and anticoincidence circuit using tunnel diodes, diodes, and transistors is described. The resolving time of the circuit measured with a meson beam is about 2 nsec. The anticoincidence efficiency is as large as 0.9997. (auth)

**7047** (NP-13357) RECHERCHE ET ÉTUDE DE TOPOGRAPHIES MAGNETIQUES À SYMÉTRIE DE RÉVOLUTION DONNANT DES TRAJECTOIRES ÉLECTRONIQUES ISOCHRONES (theses). (Research and Study of Magnetic Topographies with Symmetry of Revolution Giving the Isochronous Electron Trajectories (thesis)). Claude Maguin (Lyon. Université). [1962?]. 45p.

A study is made to determine what field configurations can give a rigorous, yet approximate ($\Delta\tau \approx 10^{-10}$ sec), isochronism and in what energy band this isochronism is evident. Only plane spectrographs and only plane trajectories contained entirely in the median plane are considered. The study is also limited to $\beta$ spectra. The trajectories are determined for constant fields and for increasing fields. The particular cases of $n = -1$ and $n = 0$ were studied for constant fields and numerical values were given for $n = +1$ and $n = +2$ in the case of increasing fields. (J.S.R.)

**7048** (NP-13363) ETUDE DE LA LUMINOSITE ET DU POUVOIR DE RESOLUTION D'UN SPECTROGRAPHE BETA UTILISANT UNE INDUCTION INHOMOGENE EN $R^{-1}$ (theses). (Study of the Luminosity and Resolving Power of a Beta Spectrograph Utilizing an Inhomogeneous Induction in $R^{-1}$ (thesis)). Joe Riche (Lyon. Université). [1962]. 79p.

The numerical calculation of the equations of motion of particles emitted at a point of the horizontal field and at points outside this plane gave point by point the trajectories of various beams. From the determination of the beam trajectories, the impact figures on the various reception planes were constructed. The method used for the study of the impact figures is given in detail. Analytical expressions for the spectra, the transmission, and the resolving power were derived as functions of the parameter, k, the diaphragms, the window length, and the reception plane chosen. It was determined that the spectra can be recorded with a constant or variable field. The fixed-field method necessitates the utilization of trajectories toward the interior of the system. The classical method permits the utilization of trajectories drawn toward the exterior of the system or around the mean direction u = 0°. (J.S.R.)

**7049** (NP-13416) SCINTILLATION PROBE FOR NUCLEAR LOGGING. V. Comanescu, M. Oncescu, P. Sandru, and A. Topa (Acàdemia R. P. R. Institutul de Fizică Atomică, Bucharest). May 1963. 15p.

A study of a new type of probe for nuclear logging, provided with a scintillation counter, is described. The probe was tested in the laboratory and in oil field conditions. A thallium-activated sodium iodide crystal was used as detector (its size being 30 mm diameter and 20 mm length), which allowed a higher accuracy for the identification of thin layers. The probe, in its actual design, can be used in oil wells and in exploration wells for minerals up to a depth of 1500 meters. Its features facilitate obtaining better information and are suitable for gamma analyses based upon energy. It enlarges also the possibilities of using radioactive tracers. (auth)

**7050** (ORNL-3499(Vol.II)(p.93-4)) SCINTILLATION EFFICIENCY OF NaI(Tl) FOR CHARGED PARTICLES. W. A. Gibson, W. R. Burrus, J. W. Wachter, and C. F. Johnson (General Dynamics/Fort Worth. Div. of General Dynamics Corp. Nuclear Research and Development Lab., Fort Worth, Tex.).

A method is described for calculating the efficiency (dl/dE) of a scintillator for a knowledge of the pulse-height distributions produced by charged particles as they penetrate the scintillator. A curve of dl/dE vs dE/dx is pre-

sented for 50- to 160-Mev protons incident on a 1.464-g/cm$^2$ NaI(Tl) crystal. (auth)

**7051** (ORNL-3499(Vol.II)(p.109-11)) PROTON-RECOIL SPECTROMETERS FROM MEASURING NEUTRON AND PROTON ENERGY SPECTRA FROM 10 TO 450 Mev. W. A. Gibson, W. R. Burrus, J. W. Wachter, and C. F. Johnson (General Dynamics/Fort Worth. Div. of General Dynamics Corp. Nuclear Research and Development Lab., Fort Worth, Tex.).

Two spectrometers for use in the neutron and proton energy ranges of 10 to 50 and 50 to 450 Mev were tested. The difficulties encountered with each spectrometer are discussed. (D.C.W.)

**7052** (ORNL-3499(Vol.II)(p.112-15)) DETERMINATION OF COINCIDENCE-CIRCUIT EFFICIENCY BY VARYING THE INPUT SIGNAL DELAY. R. W. Peelle (Oak Ridge National Lab., Tenn.).

The efficiency of a twofold coincidence circuit for counting simultaneous events is considered in terms of the jitter in the timing of the pulses at its input relative to the detected event. Two methods are suggested for analysis of empirical delayed coincidence curves for inferring coincidence efficiency. Graphs are given to relate the breadth of the jitter distribution and the coincidence efficiency to the derivative of the observed delayed coincidence curve near efficiency one-half. (auth)

**7053** (ORNL-3499(Vol.II)(p.115-19)) CALCULATION OF THE EFFICIENCY AND RESOLUTION OF A PROTON RECOIL SPECTROMETER BY MONTE CARLO METHODS. W. E. Kinney and J. W. Wachter (Oak Ridge National Lab., Tenn.).

A computer program using Monte Carlo methods was constructed to calculate the absolute efficiency and energy resolution of a proton-recoil neutron spectrometer from a knowledge of the n,p scattering cross section, the dimensions of the proton radiator, and the experimental geometry. The computation allows radiators of arbitrary thickness and a variety of source distributions and takes account of energy losses in materials intervening between the radiator and the dE/dx counter. The results given by the code agree well with infinitely thin radiator calculations made by conventional numerical integration techniques. (auth)

**7054** (ORNL-3499(Vol.II)(p.120-4)) SOME RECENT APPLICATIONS OF THE SLOP CODE FOR UNFOLDING INSTRUMENT RESPONSE. W. R. Burrus (Oak Ridge National Lab., Tenn.).

The SLOP program was applied to the analysis of pulse-height distributions resulting from the exposure of a liquid scintillator, NE-213, to Po–Be neutrons; the exposure of a plastic scintillator (Pilot B) to $Li^6(p,n)Be^6$ neutrons ($E_p$ = 2.8 and 3.1 Mev); and the exposure of a multicrystal NaI(Tl) spectrometer to $Y^{88}$ gamma rays. The response functions required by the code for the scintillators were generated by interpolation between experimental values obtained at several energies. In the case of the NaI(Tl) spectrometer, the response function was generated analytically. (auth)

**7055** (ORNL-3499(Vol.II)(p.124-6)) A CALCULATION OF THE PULSE-HEIGHT RESPONSE OF SCINTILLATORS TO HIGH-ENERGY ELECTRONS, POSITRONS, OR PHOTONS. C. D. Zerby and H. S. Moran (Oak Ridge National Lab., Tenn.).

An electron-photon cascade calculation was modified for use in calculating the pulse-height response of scintillation counters to high-energy radiations. The computer program considers a cylindrical detector of almost arbitrary composition and a source of positrons, electrons, or photons having energies up to 50 Bev. The source can be an isotropic point on the axis of the detector or a monodirectional source uniformly distributed over a circle which is concentric with the cylinder. Although the accuracy of the calculation has not yet been confirmed, the shapes of calculated and experimental curves for a plastic scintillator exposed to 129.4-Mev photons have a striking similarity. (auth)

**7056** (ORNL-3499(Vol.II)(p.127-40)) PERFORMANCE CHARACTERISTICS OF MODULAR NANOSECOND CIRCUITRY EMPLOYING TUNNEL DIODES. N. W. Hill, R. J. Scroggs, and J. M. Madison (Oak Ridge National Lab., Tenn.).

Modular circuits employing tunnel diodes were used in the instrumentation for many of the high-energy particle experiments described previously. These circuits include discriminator modules, coincidence and anticoincidence modules, positive and negative output scaler-driver modules used to drive commercially built scalers, and a 100-Mc scaler-driver module. Their response to various conditions of temperature and input pulse magnitude was measured. (auth)

**7057** (TID-19841) SELECTIVE PHOTOGRAPHY IN SPARK CHAMBERS: MICROSECOND DECISION-MAKING AND REFIRING. Robert M. Park (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). [nd]. Contract AT(30-1)-2098. 8p.

A procedure was developed for selectively extending the memory of a spark chamber for periods of >40 μsec while still maintaining sensitive times below 1 μsec. In this procedure, the spark chamber is fired with the usual fast logic but with a relatively low voltage pulse producing a discharge below photographic threshold. If a positive decision is then made with the slow logic, the chamber is fired again at a normal high voltage to produce a photographic image. The method is demonstrated using two spark chambers and cosmic ray tracks. The conditions affecting spark quality were studied briefly. (D.L.C.)

**7058** (TID-19849) COMBINATION OF TWO BENT-CRYSTAL MONOCHROMATORS FOR PRECISION WORK ON SCATTERING AND DIFFRACTION. Technical Report No. 20. K. Das Gupta (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Oct. 1963. Contract AT(04-3)-221. 12p.

An experimental arrangement that uses two bent-crystal monochromators in transmission rather than in reflection to reduce background scattering, virtually eliminate parasitic scattering beyond an angle of about 10′ of arc, and to minimize the thermal diffuse scattering near the Bragg angle without using narrow slits is described. An x-ray-diffraction pattern for anthracene shows minimal background blackening of the film. (D.C.W.)

**7059** (UCLA-516) PHOTOGRAPHIC DOSIMETRY: AN ANNOTATED BIBLIOGRAPHY (SUPPLEMENT). Ruth W. Brisbane and Louis B. Silverman, comps. (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). Aug. 1963. Contract AT-04-1-GEN-12. 258p.

This report, which is intended as a supplement to UCLA-446, is a list of 500 annotated references to unclassified report, book, and journal literature, both domestic and foreign, concerning the quantitative evaluation of radiation dosage by means of photographic materials. It contains references from 1959 to date, plus older references not included in the earlier report. Reports in the field of nuclear physics which contain information in the field of dosimetry

are included, as are those concerning quantitative autoradiography. Cross references to the reports listed in UCLA-446 are included. (auth)

**7060** (UCRL-7418) GAMMA AMPLIFIER-DISCRIMINATOR. Curtis Sewell, Jr. (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 31, 1963. Contract W-7405-eng-48. 18p. (CONF-363-5)

From International Symposium on Plasma Phenomena, San Diego, Calif., Oct. 1963.

For applications involving the routine laboratory measurement of gamma radiation, an instrument is described which is simple to operate, versatile, compact, and reliable. It consists of a pulse amplifier with charge-sensitive input and delay-line shaping, a differential discriminator capable of covering the range from 2 kev to 4 Mev, a calibration pulser, and a power supply. All controls are calibrated directly in terms of gamma energy. Construction is modular for ease of maintenance, and all circuits use solid-state components. (auth)

**7061** (UCRL-10732) A TECHNIQUE FOR MEASURING NEUTRON SPECTRA IN THE RANGE 2.5 TO 30 Mev USING THRESHOLD DETECTORS (thesis). John Clayton Ringle (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 11, 1963. Contract W-7405-eng-48. 226p.

Threshold detectors are used as the energy-dependent neutron detectors, with the restriction that after the threshold reaction has occurred the residual nucleus must emit a gamma ray. The activity of each detector is then determined by counting it with a NaI(Tl) scintillation crystal. The (n,p), (n,$\alpha$), and (n,2n) threshold reactions were used, and the criteria for the detectors were established. The cross sections for 29 threshold reactions satisfying the criteria were calculated on the basis of the continuum model of the nucleus. The calculated cross sections agree well with the experimental data. Various methods of calculating the neutron energy spectrum were studied; the polygonal, cross-section expansion, and Legendre polynomial expansion methods were found to be acceptable. All of these methods use the measured activities and the calculated cross sections to produce the neutron spectrum. Computer programs were developed to analyze the gamma spectra, calculate the cross sections, and generate the neutron spectrum. The entire method was checked by measuring a Po–Be neutron spectrum; the spectrum calculated by our method agrees quite well with previous measurements. (119 references). (auth)

**7062** ON THE CALCULATION OF THE ANGULAR RESOLUTION CORRECTION IN ANGULAR CORRELATION MEASUREMENTS. D. Berényi and T. Balogh (Inst. for Nuclear Research, Hungarian Academy of Sciences, Debrecen). Acta Phys. Acad. Sci. Hung., 16: 195-200(1963).

Based in principle on Rose's calculations, closed formulas and tables are given, from which, knowing certain data of the experimental angular resolution curve, the factors for the correction of the angular correlation coefficient for the finite dimensions of detectors are obtained. (auth)

**7063** ON THE TRANSMISSION FUNCTION OF NEUTRON CHOPPERS WITH STRAIGHT SLITS. T. Nagy, I. Pavlicsek, and L. Nagy (Central Research Inst. of Physics, Hungarian Academy of Science, Budapest). Acta Phys. Acad. Sci. Hung., 16: 207-16(1963).

The transmission function is derived for neutron choppers having straight slits by means of geometrical considerations. Misalignment manifests itself in the shape of the transmission curve, and the measured shape permits to locate and estimate any error in alignment. The results of the calculations are verified experimentally. (auth)

**7064** PREPARATION AND PROPERTIES OF A BORON CONTAINING SCINTILLATOR FOR THE DETECTION OF SLOW NEUTRONS. J. L. Verhaeghe, G. Thielens, and W. L. Creten (Rijksuniversiteit, Ghent). Appl. Sci. Res., Sect. B, 10: 247-56(1963).

Scintillators for the detection of slow neutrons were obtained by pressing mixtures of $H_3BO_3$ and ZnS(Ag) phosphor into thin, slightly transparent disks. In order to obtain optimal conditions, the influence of mixing-ratio, thickness, and pressure on detection efficiency was studied. The scintillator obtained in this way was compared with a commercial NE 400 slow neutron boronpolyester detector. (auth)

**7065** NON-LINEARITY EFFECTS IN PHOTON-COUNTING DEVICES. C. Smit and C. Th J. Alkemade (Rijksuniversiteit, Utrecht). Appl. Sci. Res., Sect. B, 10: 309-15(1963).

The upper limit of the intensity range in which the photon counter can be used with advantage is determined by the properties of the electronic apparatus. The reported effects of pile-up and dead time cause a deviation from linearity of this measuring device at higher light intensities, which is theoretically accounted for. The conditions under which the counting device operates strictly proportionally are investigated. For our apparatus the deviation from linearity is less than 3% at $10^4$ pulses per sec. (auth)

**7066** SCINTILLATION BETA-COUNTER FOR (LAS) APPARATUS. E. I. Zaytsev. Byul. Nauchn.-Tekhn. Inform. Min. Geol. i Okhrany Nedr SSSR, No. 2, 37-9(1961).

A beta-counter, intended for analyzing the $\beta$-activity of powdered samples of low weight, is described. The sensitive element is a cylindrical pot of scintillation plastic with an inner diameter of 16 mm and a wall thickness of 1.3 mm. The scintillator's side walls are enveloped with a layer of magnesia. During measurement the sample under investigation is placed inside the cap. The discrimination level is set at 7–15 kev according to the scale for the energy of NaI(Tl); this ensures the recording of $\beta$-particles with an energy of 30–50 kev and above. The use in the beta-counter of a luminophore in the form of thin-walled, scintillation-plastic pot guarantees that the measurement results are little influenced by the sample's accompanying $\gamma$ radiation. The tests made with the scintillation beta-counter showed that it has a high sensitivity for determining samples of low weight. (Referativnyy zhurnal, Geofizika, No. 6, 1962)

**7067** THERMOLUMINESCENT RADIATION DOSIMETRY UTILIZING LiF. J. R. Cameron, D. Zimmerman, G. Kenney, R. Buch, R. Bland, and R. Grant (Univ. of Wisconsin, Madison). Health Phys., 10: 25-9(Jan. 1964). (TID-19144)

A radiation dosimeter utilizing the thermoluminescent properties of LiF was developed. The instrument for measuring the light emitted by the LiF is simple, accurate and can be built for less than $500. The dosimeter has a useful range from 10 to $10^5$ r with an accuracy of better than 5%. The 35-mg sample of commercially available LiF is reusable and is used in loose, crystalline powder form, allowing considerable versatility. At 30 Kev effective the response is only 25% greater than at 1.2 Mev. The stored thermoluminescence decays less than 5% per year and is unaffected by visible light, moisture, or mechanical vibration. The dosimeter has a useful response to x rays, $\gamma$ rays, thermal neutrons, and electrons. It was used for routine clinical studies and for research on thermoluminescent phenomena. (C.H.)

**7068** CARBON DIOXIDE PROPORTIONAL COUNTERS: EFFECTS OF GASEOUS IMPURITIES AND GAS PURIFICATION METHODS. D. Srdoč (Institute "Ruder Boskovic",

Zagreb) and A. Sliepčevic. Intern. J. Appl. Radiation Isotopes, 14: 481-8(Nov. 1963).

Systematic investigations were made of the influence of the addition of small quantities of gaseous impurities in the operation of $CO_2$-filled proportional counters. The impurities added were divided into 4 groups according to their character: omnipresent gases, such as air and water vapor, including gases evolved from glass; nitrogen and sulphur oxides, which are formed during combustion of the sample in organic analysis; electronegative gases, such as halogens, which are generally considered as very effective in lowering the counting rate of a $C^{12}O_2 + C^{14}O_2$-filled counter at a given voltage; and organic vapors, which are considered to be the quenching agents, thus improving the characteristics of a counter. A series of diagrams shows the effect of contamination of $CO_2$ on counting properties of carbon dioxide-filled counters. A method of purification using a vacuum technique is presented. All contaminants were successfully removed by this method, and counting rates and plateau slopes again reached the values prior to contamination. (auth)

**7069** ABSOLUTE STANDARDIZATION WITH A NaI(Tl) CRYSTAL. III. CALIBRATION OF $\beta^+$-EMITTERS. G. A. Brinkman and A. H. W. Aten, Jr. (Inst. for Nuclear Physics Research, Amsterdam). Intern. J. Appl. Radiation Isotopes, 14: 503-10(Nov. 1963).

The absolute standardization of $\beta^+$-emitters, emitting one $\gamma$ ray, is possible with a NaI(Tl) crystal. No corrections for angular correlations are required if the absolute activity, N, is calculated from the formula $N = (A_1A_3/A_{13}) + T$. $A_1$ is half the area of the annihilation photopeak, $A_3$ the area of the $\gamma$-ray photopeak, $A_{13}$ half the area of the sumpeak, and T the area under the whole spectrum. Other equations are also given involving correction factors for angular correlation, which can be rather large. The method was tested with $Na^{22}$. The absolute standardization of pure $\beta^+$-emitters (no $\gamma$ rays) is only possible inside the well. The correction for angular correlation is the same as for $Na^{22}$ and can be obtained from measurements on this nuclide. The method was tested with $F^{18}$. For both isotopes the accuracy was of the order of 2%. (auth)

**7070** A PORTABLE APPARATUS FOR MEASURING EXPOSURE IN ROENTGENS FROM STRONG $\gamma$-RAY SOURCES. J. H. Aitken and W. H. Henry (National Research Council, Ottawa). Intern. J. Appl. Radiation Isotopes, 14: 511-16(Nov. 1963).

An apparatus is described for measurement of the radiation from cobalt-60 and cesium-137 sources. Precision (±0.1%) and long-term stability (±0.2%) combined with portability and ruggedness were aimed for in its design. A fully guarded cavity ionization chamber is used in a Townsend balance circuit, with an amplifier-electrometer to sense the null. The ionization current is collected on a teflon-dielectric capacitor and the balancing potential, derived from a source stabilized by zener diodes, is read directly from the dial of a ten-turn potentiometer. Possible errors arising from the response of the chamber to the scattered radiation from large cobalt-60 sources are considered in the light of recently published spectral information. (auth)

**7071** A MULTILAYER IONIZATION CHAMBER USED IN THE SPECTROMETRY OF RARE EVENTS INVOLVING THE EMISSION OF A LONG-RANGE $\alpha$-PARTICLE. V. N. Andreev and S. M. Sirotkin. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1253-7(Oct. 1963). (In Russian)

A thin foil or film can be placed in front of the $\alpha$ emitter in order to absorb completely the short-range $\alpha$ particles and allow the long-range $\alpha$ particles to pass through. The solid angle can be significantly increased without loss of resolution, if the ionization in the absorber is compensated for. A layer of 90% argon and 10% methane 1.9 cm thick at atmospheric pressure was used for compensation. The long-range $\alpha$ particles pass through an aluminum foil 28 $\mu$ thick and through two proportional counters which are arranged to serve as a 45° collimator, and come to rest in a grid ionization chamber. Collimation of the $\alpha$ particles improved the resolution. The two proportional counters operate with a gaseous amplification factor of 2 to 4. The first proportional counter has a higher amplification than the second counter in order to compensate for the ionization losses in the blocking foil. The impulses from the two counters and from the grid chamber are summed, and sent to a multichannel amplitude analyzer. The use of a triple coincidence scheme increased the stability of the unit. Under ordinary conditions, the background is 1 count · $hr^{-1}$, and it is 5 counts · $hr^{-1}$ in a neutron flux of $\sim 2 \times 10^7$ neutrons $cm^{-2}$ $sec^{-1}$. The resolution of the chamber for long-range $\alpha$ particles was better than 5%. (TTT)

**7072** RESULTS OF MEASURING A FAST NEUTRON SPECTRUM BY USING A METHOD OF COUNTING EFFICIENCIES. G. G. Doroshenko, V. I. Glagolev, I. R. Barabanov, and I. V. Filyushkin. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1308-12(Oct. 1963). (In Russian)

The integral count rate $N(B_i)$ can be related to the differential spectrum f(E) as follows: $N(B_i) = \int_{E_{min\,i}}^{E_{max}} f(E)\epsilon(E,B_i)dE$. Here $B_i$ is the energy threshold of the counter; $\epsilon$ is the counting efficiency; $E_{min\,i}$ is the start of the i-th counting efficiency, and E is the energy of the primary radiation. The energy distribution can be represented by the set of following equations: $N_i = \Sigma_{k=i}^{n} f_k A_{ik}$. An approximate value of $f_k$ is obtained for a given value of $E_k$. This equation can be transformed to the following form: $\Delta^2 N_i = \Sigma_{k=i}^{n} f_k \Delta^2 A_{ik}$. The reciprocal matrix of this set of equations is tabulated for a 30 × 30 mm stilbene crystal on the basis of the counting efficiencies for various energy values. This method was used to determine the fast neutron spectra from Po–B and Po–Be sources. Good agreement between the measured and theoretical spectra was observed for the Po–B source. The results for the Po–Be spectrum were in good agreement with the literature data. A counting time of ~1 hour is required for a low neutron flux of 20 neutrons $cm^{-2}$ $sec^{-1}$ in order to determine the neutron spectrum with a statistical error of 10%. This method can also be used in determining $\gamma$ spectra. (TTT)

**7073** HIGH-LATITUDE GEOPHYSICAL STUDIES WITH SATELLITE INJUN 3. I. DESCRIPTION OF THE SATELLITE. B. J. O'Brien, C. D. Laughlin, and D. A. Gurnett (State Univ. of Iowa, Iowa City). J. Geophys. Res., 69: 1-12(Jan. 1, 1964).

The satellite Injun 3 and its scientific payload, which was used in geophysical studies, is described. The satellite was launched into an orbit with apogee altitude 2785 km, perigee altitude 237 km, orbital inclination 70.4°, and period 116 minutes. One axis is continually aligned to within a few degrees of the local geomagnetic field vector by a permanent magnet. Eight directional detectors point at right angles to this axis and therefore measure trapped, or Van Allen, radiation. There are three omnidirectional particle detectors. Six particle detectors point upward in the northern hemisphere and therefore detect particles that are being precipitated to cause auroras. Two photometers, with 5577 and 3914 Å filters, point down the axis to view these auroras in the northern hemisphere, while another 5577 Å photometer serves the same purpose in the southern hemisphere. With a loop antenna, very-low-frequency electromagnetic radiation in the frequency range about 500 c to about 10 kc is de-

tected, and a frequency and amplitude analysis is performed. The characteristics of the proton detectors that cover the energy range ~50 kev to more than 100 Mev and the electron detectors that cover the range ~5 kev to ~5 Mev are discussed. (auth)

**7074** THE INDEPENDENCE OF ENERGY MEASUREMENT OF GAMMA-RAYS BY MEANS OF PLASTIC SCINTILLATORS WITH ADDED SUBSTANCES. R. Kempe (Technische Hochschule, Dresden). Kernenergie, 6: 553-8 (Oct. 1963). (In German)

It is shown that by admixtures of suitable substances the energy dependence of plastic scintillators of finite thickness can be decreased. With mercury diphenyl and iodine biphenyl as mixing substances for polystyrol scintillators, in the energy region from 35 kev to 3 Mev an energy dependence that amounted to less than ±20% was achieved. With the help of the Glocker formula and some corrections, of which the most important is for the binding energy of the shell electrons, it is possible to calculate the energy dependence of filled scintillators. The calculated values agreed very well with measured ones. The scintillators are prepared by thermal polymerization. (tr-auth)

**7075** TWO-CRYSTAL SCINTILLATION PAIR-SPECTROMETER. B. Ziegler, J. M. Wyckoff, and H. W. Koch (National Bureau of Standards, Washington, D. C.). Nucl. Instr. Methods, 24: 301-15(Sept. 1963).

A total absorption x-ray spectrometer has been developed in which a coincidence requirement selects only those x-ray photons that have produced an electron-positron pair near the surface of a large sodium-iodide scintillation spectrometer. The x-ray energy resolution of the spectrometer that results is 2.0 ± 0.2% and the detection efficiency is 4.6 ± 0.5% for 17.6-Mev $Li^7(p,\gamma)$ rays. Measurements and calculations of resolutions and efficiencies for 6 to 100 Mev photons are given, as well as an illustration of the spectrometer application to the measurement of synchrotron bremsstrahlung spectra transmitted by long absorbers. (auth)

**7076** NOTE ON THE DISTORTION OF BETA SPECTRA FROM BACKSCATTERING. J. H. Hamilton and W. H. Brantley (Vanderbilt Univ., Nashville). Nucl. Instr. Methods, 24: 325-6(Sept. 1963).

Fermi-Kurie plots of the positron spectrum of $Na^{24}$ are plotted as a function of the thickness of the Al source-backing material. It is found that placing a 140-$\mu g/cm^2$ Al foil behind the source produces a pronounced change (about 9%) in the spectrum below about 100 kev. (T.F.H.)

**7077** A HIGH RESOLUTION COMPTON-SPECTROMETER USING A SEMI-CONDUCTOR DETECTOR. H. Hick, K. Rumpold, and P. Weinzierl (Inst. of Physics, SGAE, Seibersdorf, Austria). Nucl. Instr. Methods, 24: 327-8 (Sept. 1963).

A Compton-recoil gamma spectrometer is described in which the gamma photons are collimated, strike a Li-drifted Si detector, and produce Compton electrons plus recoil gamma rays. The recoil gamma rays are detected at a prescribed backscattering angle, in coincidence with the Compton electrons, by a scintillation detector. The Si detector has a resolution of about 1.6%. (T.F.H.)

**7078** OBSERVATION OF COINCIDENT NUCLEAR REACTION RECOILS IN SOLID STATE DETECTORS. L. Van Der Zwan, C. D. Porterfield, and R. C. Ritter (Univ. of Virginia, Charlottesville). Nucl. Instr. Methods, 24: 329-30(Sept. 1963).

Two solid-state detectors in coincidence are used to detect the $C^{13}$ and $N^{14}$ residual ground-state nuclei from the reactions $C^{12}(d,p)C^{13}$ and $O^{16}(d,\alpha)N^{14}$, respectively. The angular and energy distributions of these residual nuclei are measured. (T.F.H.)

**7079** STANDARDIZED MODULAR COUNTING ELECTRONICS. R. J. Walker (Purdue Univ., Lafayette, Ind.). Nucl. Instr. Methods, 24: 337-41(Oct. 1963).

Standard transistor modules were developed for a discriminator and a coincidence, anticoincidence circuit. The discriminator is sensitive to 20 ns pulses ranging from −0.05 to −2 v in amplitude, with a gated output of 40 ns duration and a −4 v amplitude. The coincidence, anticoincidence circuit gives 30 ns coincidence resolution using standard pulses from the discriminator. Both modules have provision for delaying the fast output and a slow output of +35 v amplitude and 1 $\mu$s duration pulse for scaling. (auth)

**7080** A FAST COINCIDENCE CIRCUIT. S. Kullander (Univ. of Chicago). Nucl. Instr. Methods, 24: 342-4(Oct. 1963).

A coincidence circuit with a resolving time determined by the rise time of the input pulses is described. Two input pulses of opposite polarity are added and trigger a tunnel diode, which is the fast component of the circuit. The positive output pulse from the tunnel diode and the negative output pulse from a conventional coincidence circuit are mixed in a second part of the circuit. A final output is registered only if the input pulses are strictly coincident and the tunnel diode is not triggered. The circuit was tested with photomultiplier scintillators using a 450 Mev external proton beam. A coincidence resolving time (half width of coincidence curve measured at half height) of 1 nsec was measured. (auth)

**7081** FATIGUE IN PHOTOMULTIPLIER TUBES—AN EFFECT OF THE MALTER TYPE. I. Cantarell and I. Almodóvar (Puerto Rico Nuclear Center, Mayagüez). Nucl. Instr. Methods, 24: 353-7(Oct. 1963).

The identity of the fatigue phenomenon present in photomultiplier tubes with the effect discovered by Malter as a result of electron bombardment of thin oxide films of high resistivity was established. The empirical and theoretical expressions that describe the phenomenon in photomultiplier tubes also explain the data reported by Malter, both with respect to time variations and final saturation limits. The knowledge of the nature and control of fatigue in phototubes should help to develop practical applications of the Malter effect. (auth)

**7082** UNCERTAINTIES IN TRACK MOMENTUM AND DIRECTION, DUE TO MULTIPLE SCATTERING AND MEASUREMENT ERRORS. R. L. Gluckstern (Yale Univ., New Haven). Nucl. Instr. Methods, 24: 381-9(Oct. 1963).

The effect of measurement errors and multiple scattering on the uncertainties in momenta and direction of bubble chamber tracks is reexamined. Results are given for the rms uncertainty in momentum and direction, and their correlation, for uniform weighting, and both uniform spacing and clustering of the measured points. It is shown that for measurement errors, clustering of measured points at the beginning, end, and center of the track leads to lower rms uncertainties. Estimates of the effect of multiple scattering include the contribution of single and plural small angle scattering outside the central gaussian region. The contribution of atomic electrons to the multiple scattering is treated separately. In addition the effect of small angle nuclear scattering is included. Numerical results are presented for a variety of projectiles in liquid hydrogen and propane chambers. (auth)

**7083** HIGH-GEOMETRY SYSTEM COUNTS LOW ACTIVITY LEVELS. Paul H. Gudiksen and A. W. Fairhall (Univ. of Washington, Seattle). Nucleonics, 22: No. 1, 62 (Jan. 1964).

The development and performance of a high-geometry, low background counter is described. Samples containing low levels of activity (a few cpm) are conventionally counted close to an end-window counter under an anticoincidence umbrella counter. The geometry of the counting system is $4\pi$. In principle, a gain in counting efficiency by a factor of two is obtained by placing a second detector underneath the counting sample. (P.C.H.)

**7084** UNIVERSAL SCINTILLATION COUNTER LSU-2. Waldemar Scharf. Nukleonika, 8: 213-14(1963). (In Polish)

The counter is designed to detect alpha, beta, and gamma radiations. It consists of a photomultiplier tube with a choice of five different scintillators, and a flexible housing. In one form, the housing can accept samples in a pan-type sample holder, and the counting can be done in either window or windowless form by virtue of the light-tight arrangement for sample changing. A swivel-type holder is also provided so that window-type counting can be done at nearly any angle of tilt of the photomultiplier-detector combination. The detectors are NaI(Tl), 33 mm dia. × 35 mm; plastic, 45 mm dia. × 3 mm with a 2 mg/cm$^2$ Al foil; a similar scintillator without foil; an alpha-detecting scintillator 45 mm dia. × 3 mm with a 2 mg/cm$^2$ Al window; and a similar scintillator without window. (TTT)

**7085** THE INFLUENCE OF TEMPERATURE AND AIR PRESSURE ON THE MEASUREMENT OF $\beta$ ACTIVITY WITH GEIGER-MUELLER COUNTER. H. Erbe. Telefunken Ztg., 36: 167-73(July 1963). (In German)

$C^{14}$ and $Cl^{36}$ were used as beta emitters in studies to determine the effects of temperature and pressure on the efficiency of Geiger-Mueller tubes for counting beta particles. Results are presented in tables and graphs. (M.C.G.)

**7086** GAMMA SPECTROMETRY FROM A VEHICLE. D. Williams (Atomic Energy Research Establishment, Harwell, Berks, Eng.) and K. E. G. Perry. 26p. (CONF-365-24)

From Symposium on Environmental Monitoring, Berkeley, Gloucestershire, England, Oct. 1963.

The use of a vehicle installed equipment in environmental surveys for the sensitive measurement and identification of gamma radiation is considered. Results are given of the performance of the equipment in the field when some radioactive sources were distributed to simulate deposition following a reactor accident. (auth)

**7087** SOLID STATE DETECTORS FOR INNER ZONE PROTONS. R. W. Fillius and C. E. McIlwain (Iowa State Univ., Iowa City and Univ. of California, La Jolla). p.1122-8 of "Space Research. III." New York, Interscience Publishers, 1963.

Two solid-state detectors were designed and built to measure the directional flux and spectrum of protons in the heart of the inner zone. Low-energy protons from 1 to 4.5 Mev are counted by a single diode that uses pulse-height analysis to divide the spectrum into three channels. The other detector is a two element telescope and uses coincidence and pulse-height analysis to count protons in three channels from 18 to 60 Mev. A magnetometer gating scheme is used to record data only when the detectors are facing the intense flux perpendicular to the magnetic line of force. (auth)

**7088** INSTRUMENTATION OF SATELLITE UK1 FOR OBTAINING LOW RESOLUTION SOLAR X-RAY SPECTRA. K. A. Pounds (Univ. of Leicester, Eng.) and A. P. Willmore. p.1195-1206 of "Space Research. III." New York, Interscience Publishers, 1963.

A satellite instrumentation is described that employs the energy (or wavelength) resolution of a proportional gas counter to study the spectral shape of the sun's x-ray emission near its short wavelength limit, and the variation of this spectral tail with solar activity. It is noted that the experimental limitations of this type of spectrometer are in principle determined by the properties of the gas counter itself, and these are examined in some detail in order that the expected precision of spectral measurement may be described. Some additional limitations imposed by the space vehicle itself are noted. Some very early results from the satellite UK1 are given. (auth)

**7089** IMPROVEMENTS IN OR RELATING TO GEIGER-MUELLER COUNTER TUBES. (to Philips Electrical Industries Ltd.). British Patent 943,867. Dec. 11, 1963. Priority date Oct. 14, 1960, Netherlands.

A Geiger-Mueller counter tube is designed for reduced dead times. The tube comprises a discharge space which is filled with a gas consisting of 0.005 to 25 vol % of a halogen together with a rare gas, a cathode surrounding the discharge space, and an anode arranged inside the cathode, the distance between the anode and the cathode being smaller at a number of places than one-fourth of the mean anode-cathode distance. Thus, a field intensity considerably higher than the mean field intensity is produced at the said places on the cathode. The starting voltage is also lower and a longer and flatter plateau is obtained. (D.L.C.)

**7090** APPARATUS FOR DISPLAY OF RADIOACTIVE ISOTOPES IN ORGANISMS. Gunther Kaufmann and Helmut Ernst (to Veb Vakutronik). British Patent 944,473. Dec. 18, 1963. Filed Mar. 9, 1960.

An apparatus is designed for the automatic pictorial display of the distribution of radioisotopes in organisms, particularly the human body. The apparatus comprises a trolley which is moved forward and backward on a cantilever device to traverse the organism, a scintillation detector with a collimator carried by the trolley, a column for moving the device in conformity with the scanning progression, and a recording sheet which is stationary during the forward-backward movement of the trolley but is moved synchronously with the scanning progression along a recording device which transmits recording pulses derived from the detector. Thus, scanning and photographic recording of the human body is possible in a single operation of the apparatus. (D.L.C.)

**7091** SOLID STATE DETECTOR OF RADIATION. Cyril Hilsum, David Covell Northrop, and Oliver Simpson (to National Research Development Corp.). British Patent 946,048. Jan. 8, 1964. Filed June 8, 1960.

A semiconductor detector for gamma radiation is described. The material is a homogeneous single crystal of gallium arsenide of resistivity greater than $10^5$ ohm cm and total charge carrier concentration less than $10^3$ per cm$^3$. Its impurity centers are compensated by containing a deep acceptor impurity (for example, oxygen) and a shallow donor impurity (for example, silicon) with the concentration of the deep impurity greater than that of the shallow donor impurity. (M.C.G.)

**7092** VISIBLE LIGHT TRANSPARENT NUCLEAR SCINTILLATION DETECTOR FOR FLUENT MATERIAL. Theos J. Thompson. U. S. Patent 3,114,834. Dec. 17, 1963. Filed May 2, 1960.

A scintillation detector with high sensitivity to $\alpha$ and $\beta$ particles is patented. The detector consists of a plurality of walls of solid scintillation material separated by open passages. The walls are formed of light-transmitting material, which may be anthracene, polystyrene with para-terphenyl, or polyvinyl toluene with para-terphenyl. The walls have parallel inner and outer surfaces and may be cylindrical, forming coaxial cylinders, or curved to form a spirally wound sheet. If the thickness of the walls are in the range of tenths of a mm to cms, the detector responds selectively to $\beta$ particles, and if the walls are of the order of several mils, the detector responds selectively to $\alpha$ particles. A fluid medium containing the material whose radiations are to be detected is circulated through the open passages between the walls of scintillation material. (M.P.G.)

**7093** RADIOACTIVITY SPECTROMETRY IN SAMPLE ANALYSIS. Lyle E. Packard (to Packard Instrument Co., Inc.). U. S. Patent 3,114,835. Dec. 17, 1963. Filed Apr. 9, 1962.

A spectrometry method and apparatus for simultaneously and independently detecting and counting the radioactivity from 2 or more isotopes are patented. The isotopes may be present in composite or separate sources. The apparatus contains a radiation detector to convert the energy from the radioactive decay of the isotopes into electrical pulses proportional in amplitude to the energy emitted by the decay events. The pulses are fed into a plurality of channels, and the pulses in each channel are amplified by different gain factors and then discriminated. Only selected amplitude bands of pulses are passed. Amplitude bands are selected so that pulses passed by different channels correspond primarily to decay events from different isotopes. The rate of occurrence of the discriminated pulses are separately determined for each channel. A variety of detectors may be used with the apparatus, making it possible to measure a wide range of double-label or mixed samples. (M.P.G.)

**7094** APPARATUS FOR PROVIDING AUDIBLE INDICATION OF RADIOACTIVITY. Alexander Thomas (to Laboratory for Electronics, Inc.). U. S. Patent 3,114,837. Dec. 17, 1963. Filed Sept. 28, 1959.

A radiation warning system, which may be easily incorporated into household electronic appliances, is patented. The device may be inexpensively added to home radios or television sets or to car or portable radios and provides an audible signal having a frequency that varies with radiation intensity. A radiation-sensitive element, such as a cadmium sulfide crystal, whose conductivity varies with incident radiation, is connected with a capacitor, a neon discharge tube, and a d-c voltage source to form a relaxation oscillator. The oscillator is coupled to the loudspeaker in any conventional electronic apparatus. The oscillator is designed to be quiet or provide an intermittent click at normal radiation levels and to provide a siren-like wail at radiation levels above a predetermined value. (M.P.G.)

**7095** THERMOLUMINESCENT RADIATION DOSIMETER. James H. Schulman. U. S. Patent 3,115,578. Dec. 24, 1963. Filed June 22, 1960.

A personal dosimeter using thermoluminescent material is patented. The dosimeter consists of manganese-activated calcium fluoride containing a small amount of oxide-oxygen in the crystal lattice mounted in an inert atmosphere within an hermetically sealed transparent envelope. The envelope also contains an electrical heater to raise the temperature of the thermoluminescent material above the glow temperature. The intensity of the light emitted by the material is proportional to the amount of ionizing radiation to which it has been exposed and can be measured by a photosensitive device. (M.P.G.)

# ISOTOPE TECHNOLOGY

## General

**7096** THE EFFECT OF TEMPERATURE AND CARRIER GAS ON THE LOSS RATE OF TRITIUM FROM RADIOACTIVE FOILS. G. R. Shoemake, J. E. Lovelock, and A. Zlatkis (Univ. of Houston, Tex.). J. Chromatog., 12: 314-20(Nov. 1963).

By means of a simple ionization chamber the loss rate of tritium from tritium impregnated foils was determined. An average 50 mC source was investigated, the loss rate being determined with respect to carrier gas and temperature. The maximum temperature suggested for use of the foils has been 225°C due to health hazards involved. The results confirm these figures as the maximum allowable concentration in air is not exceeded at this temperature even under the most adverse conditions. From a practical viewpoint, however, it may be desirable to operate somewhat below this temperature in order to obtain a reasonable lifetime of the source in certain carrier gases. (auth)

**7097** CALCULATIONS OF A RADIOCHEMICAL EQUIPMENT EMITTER FOR THE VULCANIZATION USING γ-RADIATION OF SPENT HEAT-EMITTING SECTORS FROM A NUCLEAR ENERGY REACTOR. V. K. Khozak. Kauchuk i Rezina, No. 12, 26-8(Dec. 1962). (In Russian)

Vulcanization by γ radiation from different heat-emitting sectors (TVS) was studied. The efficiency coefficient (e.c.) of the γ-emitter is about 1% (60% at self-absorption in TVS). The use of additional heat-emitting elements increases the equipment output by about 5 times, and provides an application for the γ-source energy. Over a period of 180 days, the 760-Mw thermal power reactor had a $10^7$ g equiv radium average activity and an average dosage absorption of 170 rad/sec. Despite non-uniformity of the dosage field, the ratio of the average absorbed to the lowest absorbed dosage is nearly unity. The calculation, using heat-emitting elements as γ source formed in the disassembly of the TVS, showed that the e.c. for γ emission can be increased by 5 times, accounting for the self-absorption drops of the γ-emitting source. (OID)

## Industrial Applications

**7098** FIRE FIGHTING SIGNALLING INSTALLATIONS WITH RADIOACTIVE PREPARATION. J. Terlecki, J. Figwer, and O. Gzowski. Budownictwo Okretowe, No. 7, 228-31(1962).

The application of radioactive preparations enables the construction of ionizing fire fighting signalling devices. A description is given of the principle of operation of ionization chambers, which are a basic element in ionizing smoke signalling apparatus in which a radioactive substance is deposited on one of the electrodes. The reaction of ionizing fire signalling apparatus on the admixture of volatile combustion products is particularly valuable, since volatile combustion products appear usually before the onset of high temperature and flame, it therefore becomes possible to detect fire at an early stage. Investigations on the fire protection of ships were aimed at the construction of an ionizing smoke signalling apparatus. Investigations were made on the influence of certain kinds of smoke on the ionizing resistance value of chambers, and a comparison of their sensitivity to photo-electric appliances. Attention is directed to protection of insulators against moisture and pollution. A block scheme is presented together with a description of the design and principle of operation of the experimental smoke signalizer. The results achieved justify hopes that appliances of this kind may in future be used for fire protection on Polish vessels. (P.C.H.)

**7099** TESTING BY MEANS OF RADIOACTIVE ISOTOPES THE MACHINABILITY OF METALS AND THE CUTTING PROPERTIES OF TOOLS MADE OF SINTERED CARBIDES. A. Latour and M. Marciniak. Mechanik, No. 8, 430-4(1962).

For making tool strength tests by the isotopic method, one or more of the elements constituting the material composition is radioactively activated. If during cutting, particles of such radioactive elements are removed from the surface of the edge, then it is possible to observe the course of its wearing off. A description is given of the choice of the radioactive isotope, the method of activating the material edge, measurement technique, method of determination of absolute real wear of the edge, measuring apparatus, the autoradiographic method, and work safety problems. The application of radioactive isotopes to the above tests makes possible by reason of its sensibility, continuous observation of the amount, and speed of wear on the edge, as depending on various machining parameters, and hence, also, investigation of the proper mechanism of such process. A short duration of tests is an advantage of the method. (Polish Tech Abstr., No. 3, 1963)

**7100** INVESTIGATION OF THE WEAR ON BLAST FURNACE REFRACTORY LININGS BY MEANS OF RADIOISOTOPES. E. Lebushke, M. Aleku, N. Andreesku, and K. Motsok. Rev. Roumaine Met., Acad. Rep. Populaire Roumaine, 8: 251-63(1963). (In Russian)

A method was developed for investigating the wear on blast furnace refractory linings by labeling various zones of the lining with γ-active isotopes. $Co^{60}$, $Ag^{110}$, $Ta^{182}$, $Zn^{65}$, and their compounds were used for this purpose. The activity of the furnace lining and the pig iron was recorded. (tr-auth)

**7101** RADIOISOTOPE VELOCITY-METER. Wlodzimierz Wisniewski. Polish Patent 44394. Apr. 21, 1961.

Description is given of a radioisotope device designed to measure velocity and head of water circulating through the boiler—feed-water system for steady and unsteady flow. Amplified discharges of a Geiger-Mueller counter, irradiated by a $Co^{60}$ source, are recorded on a constant-motion film of an oscilloscope. The velocity meter consists of cylindrical body containing a three-vane impeller. One of the vanes carries a cartridge with the radioisotope $Co^{60}$; the other two vanes are equipped with counterweights. The body is enclosed in two protecting lead antimony alloy housings. The ring-shaped housing cast together with the ring-shaped body, has a wedge-like slot that communicates with the Geiger-Mueller counter. The second housing has a conical shape. The running time of the impeller is less than 3 sec. (Referativnyy zhurnal, Silovyye ustanovki, No. 7, 1962)

## Separation and Production

**7102** (K-OA-865) THE SEPARATION OF TUNGSTEN-184. S. A. Levin, D. E. Hatch, and E. Von Halle (Oak Ridge Gaseous Diffusion Plant, Tenn.). [1961]. Contract [W-7405-eng-26]. 13p. (CONF-368-1)

From Space-Nuclear Conference, Gatlinburg, Tenn., May 1961.

The advantages of tungsten enriched in $W^{184}$ for reduced neutron absorption cross sections in rocket reactors are outlined. Preliminary estimates were made of the costs of separating tungsten isotopes to produce a tungsten material with an absorption cross section in the range of 3 to 7 barns. The estimates were made for both the case of a new gaseous diffusion plant designed for tungsten isotope separation, and for the case of utilization of existing gaseous diffusion equipment. The results indicate a cost varying from $1,000 to $10,000 per pound, depending on the amount and concentration desired. (D.L.C.)

**7103** (K-OA-1008) ENRICHMENT OF XENON-124 BY THERMAL DIFFUSION. S. Blumkin (Oak Ridge Gaseous Diffusion Plant, Tenn.). May 28, 1962. Contract W-7405-eng-26. 8p.

The ORNL Isotopes Division anticipates a demand for xenon enriched to 10% in mass 124. The estimated production requirement is one-third of a gram per day. Two cascades to achieve this are described. One requires 63 columns of the 7-foot ORNL concentric-tube type, the other 136. Essentially, the two differ only in the size of the stripping section. The smaller cascade requires a feed rate of 16.9 liters of normal xenon per day and the larger one 6.7 liters per day. The price of normal xenon is such that the larger cascade will yield product at a lower unit cost. However, if the depleted xenon is returnable or resalable, so that the net feed cost becomes a very small fraction of the market price, the smaller plant will be the more economical one. (auth)

**7104** (K-OA-1178) A BATCH ENRICHMENT OF XENON-124 BY THERMAL DIFFUSION. S. Blumkin and E. Von Halle (Oak Ridge Gaseous Diffusion Plant, Tenn.). July 29, 1963. Contract W-7405-eng-26. 8p.

A cascade was designed for producing 10 ml of xenon enriched to 10% in $Xe^{124}$. The cascade consists of one standard ORNL tube bundle with a 10-ml reservoir at the product end and one of 18 liters at the reject end. It is estimated that it will take 71 days to attain the desired $Xe^{124}$ concentration of 10%. (D.L.C.)

**7105** (M-6735(Bk.I)) GENERAL SURVEY, BMP PLANT. E. A. Belmore and R. E. Matthews—A. H. Bartlett, ed. (Hooker Electrochemical Co., Niagara Falls, N. Y.). [1958]. Contract AT(30-1)-1524. 197p.

For Drawings and Photos see CAPE-1025.

Presented are the chronological history, costs analysis, and accountability procedures of the Boron Metal Plant, a plant for the production of boron-10. The final disposition of the plant inventory is summarized. (D.L.C.)

**7106** (M-6735(Bk.II)(Del.)) TECHNICAL BMP PLANT. R. S. Kralik, R. G. Gardella, N. Bedziner, and A. H. Bartlett (Hooker Electrochemical Co., Niagara Falls, N. Y.). [1958]. Contract AT(30-1)-1524. 356p.

For Drawings and Photos see CAPE-1025.

A description is given of the process and the equipment used in the production of $B^{10}$ and $B^{11}$ enriched complex and elemental boron. Both the electrolytic reduction process and the $H_2$-hot wire reduction process are considered. Normal operation, operating difficulties, process improvements, and startup of the Boron Metal Plant are discussed. Analytical procedures are also included. (D.L.C.)

**7107** (M-6735(Bk.III)(Del.)) PLANT OPERATING INSTRUCTIONS, BMP PLANT. R. J. Kralik and R. G. Gardella—A. H. Bartlett, ed. (Hooker Electrochemical Co., Niagara Falls, N. Y.). [1958]. Contract AT(30-1)-1524. 197p.

For Drawings and Photos see CAPE-1025.

Operating instructions are presented for the Boron Metal Plant, a plant for the production of boron-10. The instructions are to be used as a textbook for the training of operators and first line supervision and as a reference book for operating difficulties. (D.L.C.)

**7108** (M-6735(Bk.IV)(Del.)) SERVICES AND MAINTENANCE, BMP PLANT. J. L. Hanner and P. Seager—A. H. Bartlett, ed. (Hooker Electrochemical Co., Niagara Falls, N. Y.). [1958]. Contract AT(30-1)-1524. 97p.

For Drawings and Photos see CAPE-1025.

A detailed description is given of the equipment and operation of all the plant services of the Boron Metal Plant, a plant for the production of boron-10. Schematic diagrams of the service piping, heating and ventilating systems, and the electrical distribution system are included. The organization of the maintenance group and the duties performed by it are discussed. (D.L.C.)

**7109** (M-6735(Bk.V)(Del.)) PROCESS DEVELOPMENT, BMP PLANT. George T. Miller (Hooker Electrochemical Co., Niagara Falls, N. Y.). [1958]. Contract AT(30-1)-1524. 22p.

For Drawings and Photos see CAPE-1025.

A summary is presented of the history and effectiveness of the research and development program associated with the Boron Metal Plant, a plant for the production of boron-10. (D.L.C.)

**7110** (M-6735(Bk.VI)(Del.)) DEACTIVATION AND STAND BY, BMP PLANT. W. A. Fuller and J. L. Hanner—A. H. Bartlett, ed. (Hooker Electrochemical Co., Niagara Falls, N. Y.). [1958]. Contract AT(30-1)-1524. 96p.

For Drawings and Photos see CAPE-1025.

A description is given of the procedure for deactivating the plant equipment, services, and buildings and for putting the Boron Metal Plant (a plant for the production of boron-10) in standby condition. Suggested procedures are given for maintaining the plant in standby condition and for reactivating it in the future. (D.L.C.)

**7111** (MLM-1167(Tr)) ANALYSIS OF THE UNSTEADY STATE IN THE THERMAL DIFFUSION CELL. Tokuro Mizushina and Ryusho Ito. Translated for Mound Lab., Miamisburg, Ohio, from Kagaku Kogaku, 25: No. 1, 34-40(1961). 16p.

An exact solution for the concentration change in a horizontal thermal diffusion cell is obtained in a form of an error function series. From the above exact solution, an approximate solution expressing the concentration gradient at the center of the cell is obtained. The approximate solution is valid for $r < 0.1$, and $Y-r$ may be expressed by a general functional relation, independent of the experimental conditions. Three methods for determining D and $\sigma$ from a short-time experiment, using the above formula, are proposed and shown to be very effective. A solution for concentration change in a membrane thermal diffusion cell is obtained, individually, for upper and lower cells. (auth)

**7112** CHEMICAL EFFECTS OF ISOMERIC TRANSITIONS: SEPARATION OF THE ISOMERS OF $Te^{127}$, $Te^{129}$, AND $Te^{121}$. Richard L. Hahn (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 39: 3482-9(Dec. 15, 1963).

The problem of the chemical separation of radioactive tellurium isomers was reinvestigated. The separation efficiencies obtained with end-window $\beta$-particle detectors for $Te^{127}$ and $Te^{129}$ are significantly less than unity and are in agreement with previously determined values. It is demonstrated, however, that these values are not proper in that they have not been corrected for differences in detection

efficiencies for the different $\beta$ particles that were observed. Use of $\gamma$ spectrometry has overcome this difficulty; measurement of the relative rate of growth of an individual $\gamma$ ray, from a sample in which the equilibrium between metastable- and ground-state isomers has been disturbed by the chemical separation, determines the percent of isomer separation, independent of detection efficiency. The separation efficiencies for $Te^{127}$ and $Te^{121}$ were found to $0.984 \pm 0.022$ and $1.0 \pm \sim 0.05$, respectively. These results also were used in support of the concept that the chemical properties of the unstable Te species formed in internal conversion are essentially independent of the details of the nuclear decay, and are the same for all Te nuclides that decay via highly converted isomeric transitions. Application of these results to the study of the decay of $Te^{129}$ is then discussed. The apparent separation factors determined for the 0.475-, 1.12-, and 0.027-Mev $\gamma$ rays in $Te^{129}$ were, respectively, $0.952 \pm 0.007$, $0.863 \pm 0.020$, and $0.254 \pm 0.005$. These values were used to obtain relative $\gamma$-ray transition probabilities in $Te^{129}$ through an analysis of the dependence of the isomer separation process upon nuclear decay parameters. (auth)

**7113** SEPARATION OF CARRIER-FREE $^{131}I$ FROM NEUTRON-IRRADIATED TELLURIC ACID. Mariko Inarida (Inst. of Physical and Chemical Research, Tokyo). Nippon Kagaku Zasshi, 84: 731-3(Sept. 1963). (In Japanese)

Separation of carrier-free $I^{131}$ from irradiated telluric acid ($H_6TeO_6$) with solvent extraction was studied. Neutron-irradiated telluric acid was dissolved in 0.3N hydrochloric acid, and $H_2O_2$ was added to the solution. From this solution carrier-free $I^{131}$ was separated by extraction with TBP and then back-extracted into a mixture of solution of 1% $NaHSO_3$ and that of 1% NaOH. For two minutes of shaking, about 94% of $I^{131}$ was recovered into the aqueous phase. The irradiated telluric acid was also dissolved in aqueous solutions of various reagents, and chemical forms of $I^{131}$ in these solutions were examined. (auth)

**7114** TAILORING THE ISOTOPE TO THE NEED. L. G. Stang, Jr. and P. Richards (Brookhaven National Lab., Upton, N. Y.). Nucleonics, 22: No. 1, 46-9(Jan. 1964).

A review is presented on the production of radioisotopes in reactors and accelerators and by the milking system. Future possibilities are also discussed. (P.C.H.)

**7115** INDUSTRIAL INSTALLATION FOR THE SEPARATION OF DEUTERIUM FROM LIQUID HYDROGEN BY RECTIFICATION. Jost Haenny. p.29-49 of "Problems of Low Temperature Physics and Thermodynamics. Vol. 2." New York, Macmillan Co., 1960. (In French)

A method for separation of deuterium from liquid hydrogen in which 99.80% $D_2O$ is produced is described. A piston compressor and an expansion turbine are used in the liquefaction system to avoid using liquid nitrogen as a refrigerant. (M.C.G.)

# MATHEMATICS AND COMPUTERS

**7116** (ANL-6697) A PRIMER ON THE ACT-III COMPILER FOR THE LGP-30 DIGITAL COMPUTER. H. C. Thacher, Jr. and R. E. Grench (Argonne National Lab., Ill.). Oct. 1963. Contract W-31-109-eng-38. 94p.

An introduction to the writing of programs for the compiler for the General Precision LGP-30 computer and to the procedures for translating and solving problems with them is presented. Language, operations, methods, and computer operation are covered. (D.C.W.)

**7117** (EUR-211.f) CODE POUR LA SOLUTION DE SYSTÈMES D'ÉQUATIONS BOOLÉENNES. (Code for the Solution of Systems of Boolean Equations). A. Debroux (European Atomic Energy Community. European Scientific Data Processing Center, Ispra, Italy and European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1963. 15p. (CETIS-53)

The theoretical bases of a program for the solution of systems of Boolean equations are presented, and an example of its application is given. The process used involves the manipulation of Boolean polynomials of high order, and the simplification of these polynomials necessitates a large number of comparisons of Boolean monomes. Two theorems that permit a substantial reduction in this number of comparisons are included. Whereas in the usual method their number grows in proportion to the square of the number of terms, here the increase is nearly linear. (auth)

**7118** ANALOGIES BETWEEN HIGHER-ORDER ANALYTICAL AND NUMERICAL PERTURBATION-ITERATION METHODS. R. A. Sack (Univ. of Wisconsin, Madison). J. Chem. Phys., 39: 3275-6(Dec. 15, 1963).

An analogy is pointed out between Hirschfelder's perturbation–iteration method for the determination of eigenvalues and eigenfunctions of linear differential operators and Roothaan's numerical procedure applicable to finite matrices. An analytical procedure analogous to Ostrowski's third-order matrix method is shown to lead to unmanageable differential equations. (auth)

**7119** ANALYTIC APPROXIMATION TECHNIQUES. Rubin Goldstein (Univ. of California, Berkeley) and Harvey Brooks. Nucl. Sci. Eng., 17: 534-6(Dec. 1963).

In the treatment of integral equations analytic approximation techniques such as variational principle or a method of successive approximations are used. The mathematical relationship of these approximations is investigated and the conditions under which they should give equivalent results are revealed. (auth)

# METALS, CERAMICS, AND OTHER MATERIALS

## General

*Refer also to abstracts 7853, 7926, and 7956.*

**7120** (GEAP-4400) ANALYSIS OF FAILURE OF TYPE 304 STAINLESS STEEL CLAD SWAGED POWDER FUEL ASSEMBLY. E. A. Lees (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Oct. 3, 1963. Contract AT(04-3)-361. 49p.

Fuel rod assembly HPD-2S was fabricated by cold swaging and irradiated in the Vallecitos Boiling Water Reactor from April 1961 to March 1963. During the irradiation period, the assembly accumulated a peak exposure of 7100 Mwd/t and experienced a maximum heat flux of 385,000 Btu/hr-ft$^2$. In March 1963, the assembly was removed from the reactor as a suspected failure and was transferred to the Radioactive Materials Laboratory for examination. Assembly HPD-2S was fabricated by three-pass cold-swaging Type 304 stainless-steel cladding over fused uranium dioxide. Thirteen rods were clad with 10-mil tubing and twelve with 16-mil tubing; the $UO_2$ densities ranged from 92 to 94 percent of theoretical. The post-irradiation examination of HPD-2S revealed longitudinal cracks in the Type 304 stainless-steel cladding of two rods. One crack occurred in a 10-mil-clad rod, and was approximately 7½ inches long; the other crack occurred in a 16-mil-clad rod, and was approximately 2 inches long. The cracks were located in the peak burnup region of the respective rods where radiation, temperature, and stress are expected to be at a maximum. In addition to the visible cracks, 10 other rods gave clad defect indications ranging from small to large when tested by ultrasonic techniques. Only a small amount of the fused uranium dioxide fuel was lost to the reactor coolant because of erosion effects. Metallographic examination of samples from the defect region revealed that rod failure was caused by localized intergranular attack. The bulk of the material was clean and fine-grained, with no general surface corrosion and no evidence of second phases or grain boundary precipitates. The intergranular attack started from the outside surface and proceeded through the cladding. Localized severe corrosion attack was also observed at strain markings and quasi-martensite platelets. It is proposed that the mechanism for failure consists of a corrosion factor which is activated or propagated by stress. Stress manifests itself in highly directional cracking occurring in regions where calculations show operating stresses should be at a maximum. Corrosion manifests itself in localized intergranular attack that often branches along strain markings and quasi-martensite platelets. (auth)

**7121** (GEMP-29A) HIGH-TEMPERATURE MATERIALS PROGRAM. Progress Report No. 29, Part A. (General Electric Co. Advanced Technology Services, Cincinnati). Nov. 30, 1963. Contract AT(40-1)-2847. 82p.

One to 10 hour stress-rupture and creep tests of arc-melted molybdenum TZM at 2000 and 2200°C in a hydrogen atmosphere show this material to be stronger than arc-melted molybdenum. This difference is decreased as the temperature is increased. When tested at 2600°C, powder metallurgy W–25Re (at.%), sintered at 2400°C, has a higher rupture strength in hydrogen than in argon. Heat treatment at 2800°C prior to stress-rupture testing yields similar results at 2600°C in hydrogen or argon. The correlation of the stress-rupture time ($t_R$) and minimum creep rate (mcr) data yields the empirical relationship $t_R \times mcr = c$ (c is a constant) for the refractory metals, tungsten, molybdenum, tantalum, and some of their alloys with W–25Re being a notable exception. The development program on fabricating high-quality W–25Re alloys has shown that the agglomeration of fine tungsten powders must be prevented to minimize tungsten agglomerates in finished sheet. The fabrication of an elevated-temperature cartridge for irradiating refractory metals was completed. Creep-rupture testing of irradiated cold-worked tungsten flat specimens continued. Several specimens were annealed at 1900°C for 1 hour and then creep-rupture tested at 1100°C. The radiation-induced hardening was not completely removed by this treatment as shown by comparison with an unirradiated specimen annealed at the same time. Tungsten resistance specimens were annealed for 1 hour at 1900°C with little change in resistance being noted for the high-irradiation specimen ($3.3 \times 10^{19}$ nvt, $E_n \geq 1$ Mev) when compared after annealing between 1000 and 1650°C. Testing of A-286 alloy specimens having the lowest boron concentration (0.00085%) showed the largest reduction in rupture life because of irradiation. Specimens having the highest boron concentration (0.010%) did not show any effect of irradiation when compared on the basis of rupture life; however, there was a marked reduction in ductility as indicated by elongation. Computer calculations were made on the initial damage state produced in finite, neutron-irradiated iron specimens. A Monte Carlo calculation was used to compute the number of primary knock-on atoms produced per incident neutron and their energy spectrum. (auth)

**7122** (HW-77954) METALLURGY RESEARCH OPERATION. Quarterly Progress Report, April–June 1963. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 15, 1963. Contract AT(45-1)-1350. 249p.

Research and development progress in physical metallurgy, reactor metals research, chemical metallurgy, and materials engineering is described. Separate abstracts were prepared for 24 sections of the report. (M.C.G.)

*For abstracts of individual sections see: 7138, 7139, 7140, 7141, 7142, 7143, 7144, 7145, 7146, 7162, 7207, 7208, 7209, 7210, 7290, 7291, 7292, 7293, 7294, 7295, 7296, 7297, 7661, and 7860.*

**7123** (HW-78962) METALLURGY RESEARCH OPERATION. Quarterly Progress Report, July–September 1963. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 15, 1963. Contract AT(45-1)-1350. 256p.

Research and development progress is reported in physical metallurgy, reactor metals research, chemical metallurgy, and materials engineering. Thirteen separate abstracts were prepared covering the various sections. (M.C.G.)

*For abstracts of individual sections see: 7147, 7148, 7211, 7212, 7298, 7299, 7300, 7301, 7302, 7303, 7304, 7929, and 7955.*

**7124** (LA-2981) OPERATING INSTRUCTIONS, PROCEDURES, AND EQUIPMENT FOR THE LOS ALAMOS

PLUTONIUM ELECTROREFINING PLANT. L. J. Mullins, J. A. Leary, and A. N. Morgan (Los Alamos Scientific Lab., N. Mex.). Sept. 9, 1963. Contract W-7405-eng-36. 34p.

The operating instructions, procedures, and equipment for the electrorefining of plutonium on the 3.5 kg scale are described. (auth)

**7125** (LAMS-3021) QUARTERLY STATUS REPORT ON LAMPRE PROGRAM FOR PERIOD ENDING NOVEMBER 20, 1963. (Los Alamos Scientific Lab., N. Mex.). Dec. 1963. Contract W-7405-eng-36. 19p.

The development and operation of the Los Alamos Molten Plutonium Reactor Experiments are described. The development and compatibility of iron–plutonium and cerium–cobalt–plutonium alloy fuels are evaluated. The fabrication and testing of the liquid sodium loop are summarized. The phase studies of plutonium alloys containing neodymium, scandium, yttrium, praseodymium, and cerium–cobalt mixtures are reported. (N.W.R.)

**7126** (LAMS-3023) QUARTERLY STATUS REPORT ON SOLID PLUTONIUM FUELS PROGRAM FOR PERIOD JULY 1 THROUGH SEPTEMBER 30, 1963. J. A. Leary, W. J. Maraman, W. N. Miner, and F. W. Schonfeld (Los Alamos Scientific Lab., N. Mex.). Oct. 1963. Contract W-7405-eng-36. 7p.

Development and properties of ceramic fuel materials containing plutonium are summarized. Information is included on preparation and properties of plutonium oxides and nitrides, properties of plutonium carbide-uranium carbide systems, crystal structure of $Pu_5Si_3$, and phase studies of plutonium-carbon-oxygen systems. (N.W.R.)

**7127** (MLM-1169) PREPARATION AND PROPERTIES OF A PLUTONIUM CARBIDE. A BIBLIOGRAPHY. C. P. Johnston, F. D. Lonadier, and J. A. Powers (Mound Lab., Miamisburg, Ohio). July 1963. Contract AT-33-1-GEN-53. 10p.

A total of 111 references is presented. The references were taken from Nuclear Science Abstracts Vols. 1 to 17 No. 10 and Abstracts of Classified Reports Vols. 1 to 17. (D.L.C.)

**7128** (NP-13464) ADVANCED TECHNOLOGY FOR PROPULSION SYSTEMS. FINAL REPORT. REFRACTORY MATERIALS. VOLUME III. J. W. Robinson (Rocketdyne. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 15, 1961. Contract NOw 60-0445-c. 155p. (R-3350-3)

The development, fabrication, and properties of refractory metals, carbides, borides, nitrides, oxides, silicides, sulfides, intermetallic compounds, cermets, cemented carbides, cemented oxides, and different types of graphites are reviewed with respect to the development of materials suitable for advanced rocket motor components. (N.W.R.)

**7129** (ORNL-3529(p.71-143)) MATERIALS STUDIES. (Oak Ridge National Lab., Tenn.).

Progress made in the development of fuels, coolants, and reactor materials for the Molten Salt Reactor Experiment is reported. Properties and structure of the materials are described along with the effects of radiation and fabrication techniques on the materials. The development of equipment and processes is investigated for the molten fuels and coolants. Analytical methods and tests are outlined. (N.W.R.)

**7130** (RFP-331) QUANTITATIVE METALLOGRAPHY OF PLUTONIUM USING POINT-COUNT TECHNIQUES. R. L. Greeson (Dow Chemical Co. Rocky Flats Div., Golden, Colo.). Jan. 2, 1964. Contract AT(29-1)-1106. 14p.

A point-counter was designed and adapted for use on a Bausch and Lomb Balphot Metallograph. The results of quantitative metallography performed on materials with two or more phases are given and some of the results are compared with x-ray analysis. (auth)

**7131** (TID-19896) RESEARCH ON GRAPHITE. Summary Report. P. L. Walker, Jr., H. B. Palmer, and W. S. Diethorn (Pennsylvania State Univ., University Park. Coll. of Mineral Industries). Dec. 1, 1963. Contract AT(30-1)-1710. 67p.

The formation and properties of graphite are described. Information is included on surface area, density, magnetic susceptibilities, x-ray diffraction data, thermoelectric power of graphite as affected by oxygen chemisorption, iron catalysis of the graphite-carbon dioxide reaction, kinetics of the graphite-carbon dioxide and graphite-oxygen reactions, electrical resistivity and thermoelectric power studies of boron-doped graphite, effect of oxidation on the surface heterogeneity of some graphitized carbons, measurement of area of molecular sieve carbons, adsorption of tracer xenon on carbons, and light microscope motion pictures of graphite single crystal oxidation. The mechanisms of fission gas diffusion in graphite are studied along the lines of structure, history, composition, radiation damage, and pore structure. The distribution of recoils and energy within selected recoil-atom source and target geometries are investigated. Solutions for the following problems are obtained: recoil distribution in a flat-plate source with non-uniform recoil generation rate, recoil distribution in a flat-plate source and target combination in which the recoil ranges are equal, and recoil momentum escape from a flat-plate source. (N.W.R.)

**7132** (WAPD-T-1595) POLYVINYL CHLORIDE REPLICA TECHNIQUE FOR HIGH BURNUP REACTOR FUELS. Thomas R. Padden (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Aug. 1, 1963. Contract AT-11-1-GEN-14. 29p. (CONF-168-3)

From 21st Annual Meeting of the Electron Microscope of America, Denver, Aug. 1963.

A replica technique was developed for use with high-burnup friable reactor fuels. The technique has been applied to materials such as $UO_2$ and $ZrO_2-UO_2$ with badly cracked microstructures and burnups as high as $50 \times 10^{20}$ fiss/cc (21.5 at. %). Two variations of the replicating procedure are described, one for light microscopy and one for electron microscopy. The combination covers the range of magnifications from 1X to 20,000X without any gaps. The procedure involves casting a primary replica from a solution of pure polyvinyl chloride (PVC) dissolved in a suitable solvent. The critical part of this PVC technique is the proper choice of solvent. Solvent mixtures containing equal parts of cyclohexanone and methyl ethyl ketone and another containing equal parts of tetrahydrofuran and pentanone were found satisfactory. The particular advantage to the use of PVC over other plastics for radioactive samples and thus the advantage of this technique is the result of the acid resistance of PVC. The replicas can be cleaned with acids such as concentrated HF and concentrated $H_2SO_4$. Replicas reading as high as 5 r $\gamma$ before cleaning have been decontaminated to less than 2 mr $\gamma$ and were suitable for handling in a controlled non-radioactive laboratory. Examples of results are presented. A specific area identification technique is also described. It is shown how this technique can be used to integrate results obtained by light microscopy and electron microscopy and to map precisely the positions of electron micrographs on low magnification light micrograph composites of irradiated fuel materials. (auth)

**7133** IMPROVEMENTS IN OR RELATING TO METHODS OF PRODUCING CARBIDES IN GRANULAR FORM. Kenneth Wallace Carley-Macauly and Gwilym Handel Williams (to United Kingdom Atomic Energy Authority). British Patent 945,063. Dec. 18, 1963. Filed Nov. 29, 1960.

A method is given for preparing U or Th carbides in granular form for reactor use. The method comprises preparing a finely divided mixture of the corresponding oxide with at least the stoichiometric amount of carbon, forming the mixture into granules of the desired size, and heating the granules to convert the oxide to carbide. The conversion of $UO_2$ into U carbide granules is described. The method is particularly applicable to the production of granules of intimately mixed U and Th carbides. (D.L.C.)

## Corrosion

*Refer also to abstracts 6913 and 7928.*

**7134** (AERE-R-4458) THE EFFECT OF SOME ALLOYING ADDITIONS ON THE OXIDATION OF ZIRCONIUM IN STEAM. B. Cox (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1963. 60p.

The oxidation curves of zirconium and binary and ternary alloys containing less than 10% of Sb, Be, Cu, Ge, Mo, Pd, Si, Sn, Te, and V in atmospheric pressure steam at temperatures of 300 to 600°C are presented. By comparing these curves with those for Zircaloy-2, an attempt was made to deduce which alloys are likely to show satisfactory behavior in high pressure steam or water. The pressure dependence of the oxidation of unalloyed zirconium was studied. It is shown that the effect of alloying elements, which apparently decrease the oxidation rate of zirconium, is not to reduce the rate of diffusion of oxygen through the oxide but to eliminate (or retard) the influence of increasing steam pressure on the oxidation. (auth)

**7135** (AERE-R-4459) OXIDATION OF A Zr–2½% Nb ALLOY IN STEAM AND AIR. B. Cox and J. A. Read (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Oct. 1963. 46p.

A Zr–Nb alloy containing less than ~5% Nb may be a possible substitute for Zircaloy-2 in water-cooled reactors. Results obtained on a single commercially produced billet of Zr–2½% Nb are given and compared with corresponding results for Zircaloy-2. Unlike Zircaloy-2, the oxidation resistance of this alloy is very much worse in air than in steam and it is this factor which may be critical in determining the suitability of the Zr–2½% Nb alloy. It is shown that the behavior of the niobium alloy in air or oxygen is similar to that of unalloyed niobium under the same conditions, and the cause of the poor behavior in air is inferred by comparison with the mechanism of niobium oxidation. By virtue of this mechanism its oxidation resistance, particularly in air, is very susceptible to differing heat treatments and fabrication procedures. In steam, its behavior is also very susceptible to the presence of free oxygen. (auth)

**7136** (DRI-2128) INTERMEDIATE-TEMPERATURE OXIDATION OF BERYLLIDES. Final Report. Frank C. Perkins (Denver. Univ. Denver Research Inst.). Sept. 1963. Contract AT(11-1)-1092. 73p.

The oxidation characteristics of $ZrBe_{13}$, $Zr_2Be_{17}$, $NbBe_{12}$, and $Nb_2Be_{17}$ were investigated at 550 to 1100°C. The zirconium beryllides tended to disintegrate and/or oxidize at very rapid rates under wet air at 650 to 900°C, while the niobium beryllides exhibited severe oxidation at 900 to 1050°C. The zirconium beryllides were susceptible to serious oxidation under wet air, dry air, and wet argon atmospheres, the minor variations in sensitive temperatures and oxidation rates being dependent upon the characteristics and protective qualities of the oxide coatings which were formed. The rapid oxidation rates at intermediate temperatures appeared to be related to the metastability of some of the oxidation products formed. Disintegration and metallic spalling effects of beryllide materials in the intermediate-temperature range were associated with the stresses generated by the formation of the oxide coatings. The immunity of modified beryllide materials containing aluminum alloy additions to severe oxidation in this temperature range was attributed to the protective qualities and stability of the thin oxide coatings which were obtained. (auth)

**7137** (GEAP-3725) SODIUM MASS TRANSFER. I. TEST LOOP DESIGN. R. W. Lockhart, G. Billuris, and M. R. Lane (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). June 1962. Contract AT(04-3)-189. 222p.

Higher system temperatures are required to reduce the operating cost of nuclear power plants cooled with sodium. However, to reliably design and operate such a plant, experimental determination of the mass transfer and metallurgical effects under representative conditions are necessary. This report presents the design, fabrication, assembly, operating procedures, and start-up data for six experimental test loops to examine the effect of steel exposed to sodium at temperatures as high as 1300°F. Until the loops are sectioned at the end of the program, corrosion data will be obtained from metallic tabs exposed to sodium at various locations in the loops under prescribed test conditions. The loops are identical in design and differ only in the material used in fabrication. One complete loop is fabricated from Type 316 Stainless Steel, one from 2¼Cr–1Mo alloy steel, and one from 5Cr–½Mo–½Ti alloy steel; two loops are constructed of Type 316SS in the heated or hot leg portion, and 2¼Cr–1Mo alloy steel in the cooled or cold leg portion. The purification side stream on these two loops is also fabricated from 2¼Cr–1Mo steel. The sixth loop is constructed of type 316SS in the hot leg and 5Cr–½Mo–½Ti in the cold leg and purification leg. In each loop the sodium coolant is purified in a side stream by means of a forced convection cold trap. In parallel with the cold trap is a plugging indicator for determining the oxygen impurity in the sodium. The test loops that contain low alloy steel are designed to operate at a maximum temperature of 1200°F, and the type 316SS loop is designed for operation at 1300°F. All loops have sample holders located in the maximum and minimum temperature regions, as well as in two intermediate regions in the hot leg and also in the cold leg. In addition, there is a special sample holder in the maximum temperature zone that can be biologically shielded. An activated steel specimen will be located in this sample holder when the radioactive tracer technique is being employed. The corrosion samples are fabricated from the same material as the sample holder, and are 1/16 of an inch thick by 3/16 of an inch wide by 3 inches long. After cleaning they will be weighed before and after test to ±0.1 mg in order to determine their change in weight. This weighing accuracy will provide a sensitivity of less than 0.06 mils per year of uniform loss of steel sample material. In order to obtain prescribed test

temperatures in the sample holders, there are electric heaters preceding the first three sample holders in the hot leg and extended surface air coolers preceding the three cold leg sample holders. Manual adjustments are made to establish test conditions. Automatic control of some of the electric power to the heaters and of some of the air to the coolers provides a trim control to maintain prescribed temperature conditions during daily changes in line voltage and ambient conditions. This control permits unattended loop operation for a period of several work shifts. To provide independent operation, each loop has an individual power transformer and electrical distribution system. A contactor interrupts all power to the loop if the stop button or any one of three over temperature trips is activated. Electrical power distribution, circuit breakers, automatic temperature controllers, inert gas control system, and temperature indication for about 30 locations on each loop are provided on the individual operating panels. The seventh instrument panel contains a level, temperature, and flow recorder for all loops and a two pen recorder for cold trap or plugging indicator data. (auth)

**7138** (HW-77954(p.5.1-4)) WATER ENVIRONMENT. W. A. Burns (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Zircaloy-2 samples exposed 125 days to 540°F water in the ETR G-7 Loop ($7.6 \times 10^{13}$ nv fast) corroded roughly 15 times the rate of comparison coupons exposed out-of-reactor to similar water conditions. Surfaces of the irradiated samples viewed through lead glass windows are smooth, dark gray, and glossy. (auth)

**7139** (HW-77954(p.5.5-11)) OXIDATION OF THORIA DISPERSION HARDENED (TD) NICKEL. D. A. Jones and R. E. Westerman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Corrosion rates of thoria-dispersion-hardened nickel in high temperature oxygen were reproducible from lot to lot and lower than wrought nickel of 99.97 and 99.997% purity. Oxidation rates increased as the oxygen pressure was increased from 5 to 700 mm. Kinetics of the oxidation process were interpreted as indicating rate control by both nickel diffusion through the oxide and some sort of phase boundary reaction. (auth)

**7140** (HW-77954(p.5.12-13)) OXIDATION OF THE SUPERALLOYS. D. A. Jones and R. E. Westerman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Specimens of hastelloy C were oxidized in 3 mm pure oxygen, 25 mm pure oxygen, and 1 atm laboratory air. Two methods of surface preparation were used, abraded through "0" emery paper and degreased, as-received. The kinetics were parabolic for abraded specimens, indicating diffusion control. Pressure had a significant effect on oxidation of as-received specimens. Weight gain began rapidly and then leveled off. (M.C.G.)

**7141** (HW-77954(p.5.14-15)) OXIDATION OF ZIRCALOY-2 AND ZIRCONIUM IN CO AND $CO_2$. D. W. Shannon (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Oxidation of crystal bar zirconium and Zircaloy-2 in CO at 600°C is lower by a factor of 10 than in steam at the same temperature. The oxidation rate of crystal bar zirconium in CO is lower than for Zircaloy-2. (auth)

**7142** (HW-77954(p.5.16-17)) OXIDATION AND DEUTERIUM ABSORPTION OF ZIRCONIUM ALLOYS IN $D_2O$ AT pD10 LiOD. D. W. Shannon and R. A. Thiede (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

After 70 days exposure to 275°C pD10 recirculated $D_2O$ Zircaloy-2 and Zircaloy-4 samples are corroding at similar rates, somewhat lower than rates for crystal bar zirconium. After initial exposures deuterium absorption has almost ceased, while oxide films continue to grow in thickness. (auth)

**7143** (HW-77954(p.5.20-3)) CORROSION OF IRON AND NICKEL BASE ALLOYS IN SUPERHEATED STEAM. H. P. Maffei (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Comparisons of the corrosion of various nickel and iron base alloys in deoxygenated 3000 psi, 550°C steam with data from oxygenated systems indicated little effect from 3 to 4 ppm $O_2$. The corrosion attack seen in metallographic sections of corroded specimens was uniform. No intergranular attack or internal oxidation was observed. (auth)

**7144** (HW-77954(p.5.24-6)) DYNAMIC CORROSION OF ALUMINUM — NONISOTHERMAL LOOP STUDY. A. B. Johnson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

In nonisothermal loop tests of aluminum alloys in 330°C deionized water, corrosion rates increased 50 to 100% as the $\Delta T$ in the loop increased from 8 to 55°C. At constant $\Delta T$ (55°C) corrosion rates increased about 35% as the pH of the deionized water, measured at room temperature, increased from 5.4 to 6.1. (auth)

**7145** (HW-77954(p.5.31-2)) EFFECT OF $CO_2$ AS AN INHIBITOR OF ZIRCONIUM HYDRIDING. D. W. Shannon (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The apparent inhibition of zirconium hydriding by $CO_2$ in $He-CO_2-H_2$ mixtures at 375 and 425°C is apparently the result of water formation by the $CO_2$ + hydrogen reaction, where water vapor is the operative inhibitor. (auth)

**7146** (HW-77954(p.5.33-5)) EFFECT OF THICK FILMS ON THE HYDRIDING OF ZIRCALOY-2. D. W. Shannon (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Previously reported increased susceptibility of oxidized Zircaloy sample to hydriding in $He-H_2O-H_2$ mixtures as the oxide layer becomes thick was confirmed by additional experiments. (auth)

**7147** (HW-78962(p.5.1-12)) CHEMICAL METALLURGY. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Order of magnitude increases in corrosion rates is attributed to $10^{14}$ nv fast fluxes (>1 Mev) in ETR irradiations of Zircaloy-2 specimens in water at 270°C (518°F). There is a trend to higher percentage corrosion hydrogen pickup in Zircaloy-2 specimens as time of exposure in the ETR G-7 loop increases. Daily ETR G-7 loop water analyses are generally slightly below 1 ppm oxygen with a range from 0.07 to 1.7 ppm. The pH is normally about 9 with variations between 7 and 10. Out-of-reactor corrosion rates in 400°C (752°F) steam of Zircaloy-2 specimens previously irradiated in the ETR G-7 loop were similar to those obtained for unirradiated samples. In detailed investigations of Haynes 25 and Hastelloy X corrosion in 1200°C (2192°F) oxygen and air, significant amounts of oxide or metal volatilization and film spalling were found. Under constant temperature operation the oxide film on Hastelloy X was more tenacious than that formed on Haynes 25. On thermal cycling extensive spallation of partially protective films on

either metal occurred. High velocity gas streams may well have the same effect on oxide integrity. Loss of oxide from Haynes 25 samples exposed to flowing tank helium at 1038°C (1900°F) for 10 days was also established. Calculations based on the assumption that the molecular ratios of metallic constituents of the oxide are like those of the metal indicated that 25% of the oxide from Haynes 25 was lost. It is not known whether oxide loss from Haynes 25 samples occurred at test temperature or during cooling. Hastelloy X samples lost little or no oxide during exposures to high temperature helium. There was internal oxidation of Haynes 25 and to a lesser degree Hastelloy X. A gas chromatograph is under evaluation utilizing a microion-cross section detector, which is said detects 1 ppm of hydrogen, oxygen, nitrogen, methane, carbon monoxide, and carbon dioxide. Despite start up and other problems associated with overall construction and design, the instrument seems capable of detection limits of 1 to 2 ppm after a number of modifications. The detector principle appears superior to thermal conductivity in both stability and sensitivity, particularly for hydrogen. Additional corrosion isotherms for Zircaloy-2 and crystal bar zirconium in purified CO and $CO_2$ were established. Small inflections in the 500°C (932°F) carbon monoxide corrosion area were noted at 25 to 30 mg/dm$^2$ and 65 mg/dm$^2$ and in the 500°C (932°F) carbon dioxide corrosion curve at 25 to 30 mg/dm$^2$. (auth)

**7148** (HW-78962(p.5.13-23)) PRTR MATERIALS DEVELOPMENT. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Corrosion and deuterium absorption curves for alpha annealed Zircaloy-2, -4, and crystal bar zirconium were extended to 112 days in 275°C (527°F) $D_2O$, pD 10 LiOD. A deuterium weight gain versus oxygen weight gain plot showed that deuterium absorption had essentially stopped. There were no indications from weight gains or hydrogen analysis that normal Zircaloy-2 (~ 20 ppm $H_2$) and prehydrided Zircaloy-2 (410 ppm $H_2$) differ significantly in corrosion behavior or corrosion-product hydrogen pickup when exposed to 400°C (752°F), 1500 psi steam containing 3 to 4 ppm oxygen. The proposed use of monosodium phosphate for control of the pH-phosphate relationship in the PRTR boiler in place of the conventional disodium phosphate additions depends in part on the corrosion of AISI 304 SS in this reagent. Uniform corrosion rates of stressed stainless steel samples in 275°C (527°F) solutions of $NaH_2PO_4$ 60 g/liter (~ 40 ppm $Cl^-$) were acceptably low. There was no indication of pitting or stress cracking. The localized corrosion of rapidly spinning aluminum disks in 300 Area water was sensitive to linear velocity of the specimen, local surface imperfection, and water chemistry. Where pH was controlled by $CO_2$ additions to 300 Area water, pitting occurred only when pH > 8. When pH was controlled by sulfuric acid additions the critical pH was 8.5. Zircaloy-2 alloyed with small amounts of beryllium and smaller additions of uranium were corrosion tested in 360°C (680°F) pH 10 (LiOH) water. Corrosion increased linearly with concentration in the range 0 to 5% beryllium. Corrosion weight gains were independent of uranium concentration from 0 to 2200 ppm. (auth)

**7149** (MSAR-62-12) EFFECT OF 1200°F SODIUM ON AUSTENITIC AND FERRITIC STEELS. PART I. PHYSICAL PROPERTIES OF MATERIALS. PART II. THERMAL SHOCK. Progress Report No. 17, January 1962. (MSA Research Corp., Callery, Penna.). Feb. 13, 1962. Contract AT(11-1)-765. 3p.

The seventeenth in a series of progress reports concerning the status of the physical property study of stainless steel and 2¼ Cr–1 Mo steel exposed to Na at 1200 and 1100°F, respectively, is presented. The testing of a type 316 stainless steel specimen in air at 1200°F was discontinued after 212,750 cycles for examination of the specimen and review of the data. The Cr–Mo steel specimens were received and testing is scheduled to start in the near future. Loops 1 and 2 for the fatigue, creep, and stress tests in Na are undergoing various testing operations and revisions. (H.G.G.)

**7150** (VDIT-81) THE CORROSION OF ALUMINIUM AND SOME ALUMINIUM ALLOYS IN HIGH-TEMPERATURE WATER. A Literature Survey. W. Uhlmann (Aktiebolaget Atomenergi, Stockholm). Nov. 1963. 26p.

A total of 66 abstracts on the corrosion of Al and, to a limited extent, Al alloys is presented. The survey covers the period 1949 to the first of 1963 and is arranged chronologically. (D.L.C.)

**7151** (VDIT-82) THE AQUEOUS CORROSION OF URANIUM AND SOME OF ITS ALLOYS. A Literature Survey. W. Uhlmann (Aktiebolaget Atomenergi, Stockholm). Dec. 1963. 19p.

A total of 52 references in abstracted form is presented on the aqueous corrosion of U and some U alloys. The references cover the period from 1952 to the beginning of 1963. (D.L.C.)

**7152** SNAP-8 MATERIALS. C. M. Scheuermann, C. A. Barrett, W. H. Loudermilk, and Louis Rosenblum (Lewis Research Center, Cleveland). Astronaut. Aerospace Eng., 1: 40-3(Dec. 1963).

The preliminary results of the reflux capsule screening program for a Snap-8 mercury containment material are presented. Of all the materials tested, tantalum and niobium-1% zirconium alloy are the most corrosion resistant. They showed no measurable penetration in 2,000 hr, the limit of tests to date. The martensitic and low alloy steels were next best in corrosion resistance for test times up to 5,000 hr, but exhibited measurable penetration. All other materials tested showed considerably less corrosion resistance for test times up to 5,000 hr. The corrosive attack of a material by mercury is directly related to the total percentage of mercury-soluble elements present in these materials. (auth)

**7153** A STUDY OF THE COMPATIBILITY OF THERMIONIC CONVERTER MATERIALS WITH CAESIUM. R. G. Smith, F. Hargreaves, G. T. J. Mayo, and A. G. Thomas (Plessey Co. Ltd., Towcester, Northants, Eng.). J. Nucl. Mater., 10: 191-200(Nov. 1963).

The reasons for the current interest in thermionic energy conversion devices in the field of nuclear energy are briefly outlined. In a cesium thermionic device the problem of corrosion of the constructional materials by cesium is of prime importance. A method was devised for carrying out compatibility tests in cesium vapor and investigations at temperatures up to 600°C are described. The materials studied include metals and ceramics likely to be employed in a thermionic converter device, and it is shown that in many cases severe corrosion can occur at temperatures as low as 300°C. Particular attention is paid to the behavior of metal-ceramic seal assemblies where the choice of materials, particularly the metallizing and brazing components, is of great importance. Most conventional commercially available seals are not entirely satisfactory and are unlikely to be suitable for prolonged use at temperatures in the region of 600°C. It was concluded that it may prove necessary to develop new methods of sealing high purity alumina to metals before the full potential of the thermionic converter can be realized. (auth)

**7154** SOME TOPOGRAPHICAL OBSERVATIONS ON THE OXIDATION OF BERYLLIUM. W. B. Jepson, B. L. Myatt, J. B. Warburton, and J. E. Antill (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 10: 224-32(Nov. 1963).

Samples of Pechiney beryllium were oxidized at 700°C in moist carbon dioxide for times varying from 15 minutes to 35 hours. Carbon replicas of their surfaces were examined on the electron microscope. Numerous small regions, each bounded by a crack, develop in the oxide layer during the very early stages of oxidation and well before a point of inflexion appears in the weight gain/time curve. The cracked regions, which apparently derive from blisters, appear to be the principal sites for the diffusion of gaseous reactants to the interior of the oxidizing sample. There is no evidence for preferential cracking of the oxide along the grain boundaries of the underlying metal. The films formed in dry carbon dioxide are extensively cracked during the initial stages but become more coherent as oxidation proceeds. The results are discussed with reference to the breakaway corrosion of beryllium in the presence of water vapor. (auth)

**7155** THE KINETICS AND MECHANISM OF NIOBIUM OXIDATION. D. A. Prokoshkin and E. V. Vasileva. Met., Metalloved., Fiz. Khim. Metody Issled., No. 13, 143-51 (1963). (In Russian)

An x-ray diffraction investigation of Nb oxidation at elevated temperatures showed that oxygen forms solid solutions with Nb and that oxidation at the lower temperatures studied produces alpha phase $Nb_2O_5$ and at higher temperatures produces alpha and beta or beta phases of $Nb_2O_5$. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7156** INVESTIGATION OF THE OXIDATION OF ALLOYS OF NIOBIUM WITH VANADIUM. D. A. Prokoshkin and E. V. Vasileva. Met., Metalloved., Fiz. Khim. Metody Issled., No. 13, 152-6(1963). (In Russian)

The kinetics of oxidation of Nb alloys containing up to 10% vanadium, were investigated by x-ray diffraction methods. The influence of vanadium content on the oxidation rate of the alloys was studied. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7157** INVESTIGATION OF THE OXIDATION OF THE ALLOYS, NIOBIUM–TITANIUM–ZIRCONIUM. D. A. Prokoshkin, E. V. Vasileva, and A. M. Ryabyshev. Met., Metalloved., Fiz. Khim. Metody Issled., No. 13, 157-62 (1963). (In Russian)

The influence of 0.5 to 25% Zr on the oxidation of Nb alloys containing 5 or 10% Ti was investigated. X-ray diffraction analysis was utilized to follow the oxidation process. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7158** ABLATION OF GRAPHITE IN OXYGEN AND AIR AT 1000° TO 1400°C UNDER FLOW CONDITIONS. E. A. Gulbransen, K. F. Andrew, and F. A. Brassart (Westinghouse Research Labs., Pittsburgh). 31p. (CONF-73-18)

From 6th Biennial Conference on Carbon, Pittsburgh, June 1963.

The ablation of high-purity graphite in oxygen and air atmospheres was studied in the 1000 to 1400°C temperature range, gas pressures of 2 to 19 torr, and flow rates of $7.6 \times 10^{18}$ to $3.6 \times 10^{20}$ atoms per second. Gas diffusion effects were eliminated by the use of small samples and fast flow rates. Very fast ablation rates were observed. The kinetic data are best fitted to a model based on mobile adsorption as the rate limiting step with a heat of activation of 39,000 calories per mole. (auth)

## Fabrication

**7159** (CONF-356-4) FABRICATION AND PROPERTIES OF SEAMLESS TUNGSTEN TUBING. P. Loewenstein, J. G. Hunt, and R. G. Jenkins (Nuclear Metals, Inc., Concord, Mass.). [nd]. Contract AT(30-1)-2784. 21p.

From 1963 American Society of Metals/Metals and Materials Show, Cleveland, Oct. 1963.

A process for the production of seamless tungsten tubing is described. The process consists of the extrusion of sintered powder sleeves at elevated temperatures to sizes close to the final dimension. The tubing is finished by warm drawing. A size range of 0.100-in. diameter to $1\frac{1}{2}$-in. diameter has been fabricated. A preliminary evaluation of properties of the extruded tubes is given. (auth)

**7160** (DP-838) COMMERCIAL FABRICATION OF PLUTONIUM FUEL. A. A. Johnson, J. E. Crawley, J. M. Hoffmann, R. T. Huntoon, and D. A. Orth (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). June 1963. Contract AT(07-2)-1. 106p.

A study is conducted of the use of Pu in power reactors with reference to the possible commercial fabrication of Pu fuels and the kind of fabrication facilities needed. The supplies and markets for Pu fuels are assessed, methods of making typical fuels are discussed, the health and safety requirements of a Pu-handling facility are presented, and construction and operating costs are estimated. A hypothetical plant design is used to illustrate the techniques and estimate the costs. Uncertainties that should be resolved before beginning plant construction are outlined. Related services that would be needed along with the plant are also described. (D.L.C.)

**7161** (GEAP-4394) FUEL CYCLE PROGRAM DESIGN AND FABRICATION OF SPECIAL ASSEMBLY 10-L. COMPACTED POWDER FUEL RODS CLAD WITH 0.127-MM WALL STAINLESS STEEL. S. Y. Ogawa and H. E. Williamson (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 1963. Contract AT(04-3)-189. 47p.

Sixteen fuel rods clad with thin type 304 stainless steel and filled with vibratory compacted powder $UO_2$ were fabricated and incorporated into a bundle for irradiation testing in the VBWR. The $UO_2$ powders were tested for gas content. $N_2$, CO, and $H_2$ were the principal gases evolved by both types of $UO_2$, but the arc-fused $UO_2$ released ~10 times as much gas as the Dyna Pak $UO_2$. The amount of gas released was also a function of particle size and temperature. The gas evolution data were used to design the gas plenum to accommodate the absorbed gases along with the fission gases. (D.L.C.)

**7162** (HW-77954(p.6.5-11)) LOOP WELDING. R. L. Knecht (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Initial design of the Mark I test section for the model high-temperature gas loop was completed and the major components are in various stages of procurement. Helium at 2050°F (1121°C) and 350 psi will move to the test section from the heater in double-contained pipe consisting of a pressure-bearing outer stainless pipe, a hot superalloy inner pipe and separating insulation; the insulation is to be Fiberfrax. A castable type of this alumina-silica fiber is being used to make the first full size insulating block for evaluation. An IBM 7090 heat transfer program was set up and run to determine the piping component temperatures and heat losses. Initial stress-rupture tests on superalloy welds involving Haynes 25 and Hastelloy X at

1800°F (982°C) indicated high weld efficiencies but the Haynes 25 samples had limited elongations. (auth)

**7163** (NP-13410) COLUMBIUM "H" SECTION PROGRAM. PHASE I. EXTRUSION. PHASE II. DRAWING. Interim Report I, July 1, 1963–October 1, 1963. E. V. Peterson (Du Pont de Nemours (E. I.) & Co. Metals Center, Baltimore). Contract AF33(657)-11293. 40p.

Phase I goal is the extrusion of D-43 (Nb–10W–1Zr–0.1C) and Nb-752 (Nb–10W–2.5Zr) "H" sections, of specified size, with section thicknesses of 0.060 inch, and lengths of at least 20 feet. Two 8-inch diameter ingots were melted of each alloy, converted to billets, and extruded to 3.7-inch diameter stock. Nine 3.4-inch diameter billets were extruded to "H" sections with thicknesses of 0.187 and 0.125 inches (extrusion ratios of 12.4:1 and 18.2:1), from 3400°F. The results are reported and the future program is discussed. Phase II goal is the drawing of extruded "H" sections of the above alloys to specified size, with section thicknesses of 0.040 inch, and lengths of at least 20 feet. Die designs were made and general equipment requirements for drawing the "H" sections studied. Appropriate preparations for drawing are being made. The future program is discussed. (auth)

**7164** (EURAEC-819) FABRICATION OF PLUTONIUM-ENRICHED NUCLEAR FUELS FOR WATER REACTORS BY VIBRATION AND VIBRATION-SWAGING. Report No. S.16. (Brussels. Centre d'Etude de l'Energie Nucleaire and Societe Belge pour l'Industrie Nucleaire, Brussels). Sept. 1963. Work Performed under United States–Euratom Joint Research and Development Program. 31p. (A translation)

The densification of $PuO_2-UO_2$ fuel elements by vibration and vibration-swaging is described. The fuels fabricated for irradiations are described. The homogeneity of the $PuO_2$ distribution in the vibrated elements is considered in detail, and the heterogeneity factor is shown to be expressed by the product of a macroscopic factor and a microscopic factor. (D.L.C.)

**7165** METHOD AND APPARATUS FOR PRODUCING HIGH-PURITY LITHIUM. T. F. Fedorov and F. I. Shamrai. Byull. Izobret. i Tovarnykh Znakov, No. 14, 54(July 1963).

A method of producing high-purity lithium that is distinguished by the fact that, for higher purification of the lithium and increasing the output of the apparatus, it is carried out by means of continuous fractionation with bubbling at a temperature of 900-1200°C, which corresponds to a pressure of 15-200 mm Hg for the lithium vapor. An apparatus for carrying out the method is described. It is constructed in the form of a fractionating column with a multilayered wall, equipped with bubble plates and gates for the continuous feed and discharge of metal, which is distinguished by the fact that, in order to improve the reliability and hermetic state of the column, its wall is made up of three layers: an inner of Armco iron, a middle of high-temperature steel, and an outer of a refractory material, whereas between the first and second layers a vacuum is created, and between the second and third is introduced an inert gas such as argon. (OTS)

**7166** FABRICATION METHOD FOR FINE-GRAINED BERYLLIUM OXIDE. K. D. Reeve and E. J. Ramm (Australian Atomic Energy Commission Research Establishment, Sydney). J. Nucl. Mater., 10: 246-7(Nov. 1963).

A brief description is given of the methods used to prepare fine-grained BeO (2–3 μm). Three marked effects of the treatment were noted. The uniformity of the sintered product was improved after short grinding times; the powder becomes less sinterable the longer the grinding time; and after 3 hr grinding in alcohol, it was possible to achieve finer grain sizes at higher densities than with untreated BeO powder sintered to the same or even lower density. (P.C.H.)

**7167** MICROGRAPHIC APPEARANCE AND MECHANICAL PROPERTIES OF ZIRCALOY-2 AFTER VACUUM HEAT TREATMENT. Y. Parnaudeau, J. Simon, and P. Laurent (Laboratoire de Métallurgie Physique, Poitiers, France). Mem. Sci. Rev. Met., 60: 762-70(Nov. 1963). (In French)

Description is given of the different micrographic appearance and corresponding hardness after Zircaloy-2 has passed more or less completely into β phase followed by more or less rapid cooling. A series of tensile tests at room and elevated temperatures on certain structures in combination with impact tests established an aging phenomenon towards 400°C. Finally, fatigue at room temperature showed that some structures are very unfavorable for this type of test. (auth)

**7168** APPLICATION OF MELTING IN THE ELECTRON-BOMBARDMENT FURNACE TO THE STUDY OF THE REFINEMENT OF ZIRCONIUM. ELIMINATION OF OXYGEN. L. Renucci, Ph. Albert, and P. Lehr. Mem. Sci. Rev. Met., 60: 829-39(Nov. 1963). (In French)

Studies were made on the refinement of zirconium by melting and treatment in the electron-bombardment furnace. As for the refractory metals it was found that the treated zirconium was greatly refined with respect to metal impurities being more volatile than the zirconium; this applies even to initial concentrations of the order of some $10^{-6}$. The removal of oxygen from the zirconium was carried out through the intermediary of the monoxide ZrO. The refining coefficient was calculated for different concentrations. (auth)

**7169** WELDING TRICKS IN NUCLEAR POWER. Metalworking Prod., 107: No. 35, 41-3(Aug. 28, 1963).

The welding of pressure vessels, nuclear power components, and Cu clad mild steel plate for use in the manufacture of a high vacuum test rig is discussed. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7170** HOW TO EXTRUDE TOUGH BERYLLIUM SHAPES. Henry Lefer. Precision Metal Molding, 21: No. 4, 40-3(Apr. 1963).

A technique is described for extruding sintered Be billets utilizing a cast Stellite die and a mica-based lubricant, Neorolene. Applications include spiral-finned tubing for atomic reactors and extrusion development of complex shapes of Mo and W. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7171** THE PREPARATION OF THIN SELF-SUPPORTING BORON FILMS. J. R. Erskine and D. S. Gemmell (Argonne National Lab., Ill.). Nucl. Instr. Methods, 24: 397-8(Oct. 1963).

A technique for the preparation of thin (20–400 $\mu g/cm^2$) self-supporting boron films by an electron bombardment method is described. The technique differs from those used previously in that it uses a water-cooled anode and a new method of removing the evaporated film from the backing. (auth)

**7172** SEVERAL ASPECTS OF WELDING NUCLEAR STRUCTURES. M. Demaret. Rev. Soudure (Brussels), 19: No. 2, 57-65(1963). (In French)

A review is presented of the applications and techniques of ultrasonic, spark, spot, argon arc, argon electrode, electron beam, pressure, forge, electroslag, and cold pressure welding, diffusion bonding, and brazing of Zr, Be, Nb, V, Hf,

Ti, Magnox, SAP, stainless steel, Th, steel, W, Al, Co, Ta alloy, Mo alloy, and Nb alloy tubes, sheets, and sheaths. A summary of corrosion, mechanical, and physical properties of welded nuclear equipment is included. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7173** WELDING AUXILIARY TUBING OF THE $BR_3$ DE MOL REACTOR. Pierre Amelot. Rev. Soudure (Brussels), 19: No. 2, 66-74(1963). (In French)

Techniques and parameters for argon arc, socket, and covered electrode welding and V chamfering of various stainless steel, mild steel, and Al alloy tubes are presented. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7174** ROLLING URANIUM. AN EXAMINATION OF SOME ROLLING SCHEDULES AND GRAIN-SIZE, HARDNESS AND MECHANICAL TEST RESULTS. N. Davies. Sheet Metal Ind., 40: 654-60(Sept. 1963).

Equipment used in processing 31 uranium slabs is described. An investigation was made of a 3-high mill and the salt bath used for preheating and annealing. Six rolling schedules with data on the effect of rolling direction on hardness, grain size, ultimate tensile strength, yield strength, and elongation were evaluated. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7175** HOT-PRESSING OF PURE OXIDE CERAMICS. D. N. Poluboyarinov and E. I. Shal'nov. Zh. Vses. Khim. Obshchestva im. D. I. Mendeleeva, 8: 148-54(1963).

Two types of apparatuses for hot pressing ceramic materials, with detailed diagrams of each, are described. The first consists of a high-frequency generator, hydraulic press, graphite press mold, and system for delivering energy to a graphite receiver. Combined heating by the thermal radiation of the receiver and press mold itself, heated by induction current, permits a more rapid increase in the temperature of the press mold, more uniform heating over the cross section, and accurate control of the composition of the medium. The second setup consists of a tubular graphite resistance furnace, placed between the two plates of a hydraulic press, which serve as electrical contacts. The press mold is either a replaceable graphite heater of a tubular furnace or a press mold inserted into the space of the tubular furnace, being indirectly heated there. In this case more powerful equipment is required, but greater safety during operation is provided. The preparation of dense ceramics by hot-pressing from beryllium oxide, magnesium oxide, calcium oxide, and aluminum oxide is discussed, and data are given on: shrinkage during sintering and hot-pressing, variation of the density during hot-pressing, dependence of the volume weight on the crystal dimensions, crystal dimensions as a function of the temperature during hot-pressing and purity of the initial material, and thermal shock-resistance (BeO); thickening during hot-pressing, specific surface, equivalent spherical diameter, pressure needed to produce a set density (MgO); variation of the density under various systems of treatment (CaO). Data and empirical equations are given for the density variation of seven different types of alumina and analogous comparison compounds under various annealing systems and photomicrographs of the microstructure of hot-pressed $Al_2O_3$ after treatment at three different temperatures. (TCO)

**7176** LARGE PARTICLE 75 WEIGHT PERCENT $UO_2$–BeO PELLET FABRICATION. R. Zocher, R. Landingham, and C. Funk (Aerojet-General Nucleonics, San Ramon, Calif.). 10p. (CONF-316-1; AGN-TP-53)

From American Ceramic Society 16th Pacific Coast Regional Meeting, Los Angeles, Oct. 1963.

Studies were made on the process development and fabrication on a semi-production basis of enriched $UO_2$–BeO pellets. Greater than 72% of the 0.1805 in. dia pellets exhibited an acceptable diameter tolerance of ±0.0015 in. and an acceptable density (>94%) through control of cold-pressed green density. An overall process yield of 90.1% acceptable pellets was obtained by centerless grinding oversize pellets. The average $UO_2$ content in each pellet batch can be held within 1% of the desired 74.9 wt %. The desired fuel loading of 74.9 wt % $UO_2$ can be maintained within three sigma limits of 1.5% (95% confidence level) during continuous production. (P.C.H.)

**7177** METHODS FOR BRAZING UNUSUAL METAL COMBINATIONS. Robert C. Bertossa (Pyromet Co., San Carlos, Calif.). Metals Park, Ohio, American Society for Metals, 1963, Technical Report No. 1-2, 11p., $3.00. (CONF-356-3)

From 1963 American Society of Metals/Metals and Materials Show, Cleveland, Oct. 1963. 23rd National Convention of the Society for Nondestructive Testing.

A method for vacuum pressure braze cladding is described. Application of the method to Mo–OFHC Cu-type 316L stainless steel, Ta cladding on OFHC Cu, Nb with Ni, Ti and Zr on steels, and pure Be brazing to austenitic stainless steel are discussed. The advantages of vacuum-pressure bonding are also discussed. (P.C.H.)

**7178** FABRICATION AND PROPERTIES OF TANTALUM-BASE ALLOYS. A. L. Feild, Jr., R. L. Ammon, A. I. Lewis, and L. S. Richardson. p.139-60 of "High Temperature Materials. Pt. 2. Vol. 18." New York, Interscience Publishers, 1963.

Tantalum-base alloys were tested to determine the feasibility of improving the mechanical properties at temperatures above 1000°C. Microstructures, hardness at room and elevated temperatures, workability, and oxidation resistance were determined as a function of alloy content in both the cast and 2000°C homogenized conditions. Investigation of the effects of binary and ternary additions of tungsten, Hf, Re, Mo, Cr, V, Ti, and Zr were also studied. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7179** EXTRUSION DEVELOPMENT FOR TUNGSTEN, TANTALUM AND COLUMBIUM ALLOYS. A. S. Nemy and R. L. Faunce. p.669-83 of "High Temperature Materials. Pt. 2. Vol. 18." New York, Interscience Publishers, 1963.

The principal problems of extruding Nb, W, and Ta and their alloys are discussed in detail with emphasis on the surface contamination of the material and its effect on the quality of the product. The extrusion of structural shapes is discussed and data given for a Ta-10% W alloy. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7180** HIGH-ENERGY RATE EXTRUSION OF COLUMBIUM-BASE ALLOYS. R. T. Begley and R. L. Ammon. p.685-702 of "High Temperature Materials. Pt. 2. Vol. 18." New York, Interscience Publishers, 1963.

The Dynapak extrusion process is evaluated with regard to its application for extruding Nb alloys. Data are presented concerning the effect of die geometry and lubrication on the product quality. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7181** PREPARATION OF CERAMIC-GRADE THORIUM–URANIUM OXIDE. G. Cogliati, R. De Leone, S. Ferrari, M. Gabaglio, and A. Liscia (Centro Studi Nucleari Della Casaccia, Rome). p.37-53 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. I." Vienna, International Atomic Energy Agency, 1963.

A method for the preparation of sintered bodies of thorium–uranium mixed oxide starting from a solution of thorium nitrate and uranyl nitrate was investigated. The method can be useful both in the fabrication of fuel elements and in the reprocessing of such type of materials. In the first step, uranyl nitrate is reduced to uranium(IV) nitrate. As reducing agent, both gaseous hydrogen and formic acid are employed; urea is added to prevent the formation of nitrous acid, which catalyses the reoxidation of uranium(IV). As catalyst, both platinum and palladium can be employed. Data are given for a continuous process, in which formic acid and urea are added to the solution, which is then pre-heated and passed in a column packed with $\frac{1}{8}$ in. × $\frac{1}{8}$ in. alumina pellets, carrying 0.5 wt % of platinum. The influence of flow rate, temperature, formic acid, and urea concentration, as well as catalyst life and poisoning was studied. The second step in the method is the precipitation of an oxalate of thorium and uranium(IV). The influence of oxalic acid to thorium–uranium ratio, temperature, aging time on settling and filtering characteristics of the precipitate and on the ceramic properties of the obtained powders is reported. Firing was carried out both in reducing and oxidizing atmosphere. After preliminary tests, two standard procedures were set up for the fabrication of ceramic bodies, namely by cold pressing and sintering and by extrusion and sintering. The ability of the different powders to sinter was tested by both of the two standard methods. With some of the powders, densities higher than 95% of theoretical density were obtained; reproducibility tests were successfully carried out. (auth)

**7182** PREPARATION OF URANIUM DIOXIDE BY ELECTROCHEMICAL REDUCTION IN AMMONIUM CARBONATE SOLUTIONS AND SUBSEQUENT PRECIPITATION. V. Pravdić, M. Branica, and Z. Pučar (Inst. "Rudjer Bosković," Zagreb). p.55-63 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. I." Vienna, International Atomic Energy Agency, 1963.

Experiments in a small scale electrolysis cell on cathodic reduction of uranium(VI) to uranium(IV) show the possibility of an efficient way to obtain uranium(IV) in carbonate solutions. From this solution uranium(IV) hydrous oxide precipitates by merely raising the temperature. To obtain larger quantities of material needed for technological testing, a scale-up of the process was attempted. An electrolysis cell of hard PVC (polyvinylchloride) was constructed with a mercury pool cathode of approximately 2.5 $dm^2$ and platinum anodes. The catholyte was separated from the anolyte by cation-exchange membranes. The catholyte was circulated between two 50-l reservoirs and streamed toward the vigorously stirred mercury cathode. The working potential of mercury was controlled against an Ag/AgCl/KCl (sat.) reference electrode, the potential being held constant at −1.5 v. The current efficiency is approximately 90%; the power consumed for the reduction process is about 0.8 kwh/kg of uranium dioxide. After the electrolysis was completed the precipitation was initiated only by heating the deeply green clear solution up to 70°C in a separate all-glass vessel of 60-l volume. From 50 l of the catholyte solution 1 kg of a centrifuged product (containing about 20% of water) was obtained. The coulometric analysis of the oxygen–uranium ratio always gave results in the range of 2.04 to 2.09. By the procedure described uranium(IV) hydrous oxide is selectively precipitated, and the oxygen–uranium ratio in the precipitate was found to be independent of the degree of completion of the reduction. The product was identified as the alpha phase of uranium dioxide by x-ray powder diffraction. (auth)

**7183** STUDY OF PHASE TRANSFORMATION AND SPECIFIC SURFACE IN THE MANUFACTURE OF URANIUM DIOXIDE FROM AMMONIUM DIURANATE. G. Landsperskii, D. Imrišova, L. N. Sedlakova, and Z. Urbanec (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Řež). p.79-94 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. I." Vienna, International Atomic Energy Agency, 1963. (In Russian)

A study was made of phase transformations occurring upon calcination of ammonium diuranate and the effect thereof on the change in specific surface of $UO_3$. At the temperatures of formation of stoichiometric $UO_3$ there is a considerable increase in specific surface. This correlation applies also with respect to the specific surface of the final uranium dioxide. The decomposition products were subjected to x-ray examination and to infra-red spectroscopy. At a temperature of 200°C a $UO_3$ phase was revealed together with an amorphous trioxide, the amount of which decreased with increasing temperature. (auth)

**7184** ON THE CONVERSION OF $UF_6$ TO $UO_2$. D. Kolar, J. Slivnik, and B. Volavšek (Nuclear Inst. "Jozef Stefan," Ljubijana, Yugoslavia). p.109-16 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. I." Vienna, International Atomic Energy Agency, 1963.

A complex ammonium uranium fluoride was prepared by the reduction of uranium hexafluoride with ammonia in the gaseous phase at 40°C. The very fine product was retained in electrical precipitators and converted into uranium dioxide by pyrohydrolysis with water vapor and hydrogen in the temperature interval between 500 and 600°C. The reaction was followed by differential thermal and thermogravimetrical analysis. The uranium dioxide was analyzed for fluorine and oxygen content and the crystal structure was checked by x-ray analysis. Several physico-chemical characteristics, such as specific surface area, particle size, and tap density of the powder, were determined. From the powder, the pellets were pressed and sintered at 1350°C. Depending on the various conditions of preparation, densities up to 94% of the theoretical values were achieved. (auth)

**7185** INFLUENCE OF THE PREVIOUS HISTORY OF THE RAW MATERIAL ON SINTERING OF $UO_2$. E. Aparicio, J. A. Alonso, and J. D. Pedregal (Junta de Energiá Nuclear, Madrid). p. 191-203 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. I." Vienna, International Atomic Energy Agency, 1963. (In Spanish)

An account is given of the experimental principles underlying the production process of a $UO_2$ pellet plant. In this process, advance determination of the particle-size distribution characteristics of the raw material is secured not by means of controlled precipitation but by the crushing and grading of powders. The uranium oxides tested were conventional materials, representing types of fabrication that differ by origin and method used. A study of the pellets obtained shows the potentialities and limitations of each type of oxide in the process adopted. A description is given of the characteristics of the powders as regards specific area, particle-size distribution, differential and thermogravimetric thermal analyses, and stoichiometry, and of the density, contraction, structure, and stoichiometry of the pellets. (auth)

**7186** SOME EFFECTS OF FABRICATION VARIABLES ON THE SINTERING OF BERYLLIA POWDERS. J. S. O'Neill and D. T. Livey (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.205-24 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. I." Vienna, International Atomic Energy Agency, 1963.

The fabrication of three beryllium oxide powders, char-

acterized by electron microscopy, surface area measurement and particle-size analysis, was studied by cold pressing and then sintering in a $N_2-H_2$ atmosphere at temperatures up to 1800°C. Two of the powders were found to be readily sinterable to near theoretical density at moderate temperature (1500°C) but the third, of lower surface area, required a high compacting pressure (~50,000 lb/in$^2$) and very high temperature (>1700°C) to reach densities greater than 95% of theoretical density. Variation of pressed density was found to affect the rate of increase of density markedly but did not appear to have a strong influence on the density ultimately achieved. Preliminary grain growth data for two of the powders are also reported. (auth)

**7187** THE EFFECT OF $UO_2$ AND OTHER OXIDES ON THE SINTERING, RECRYSTALLIZATION, AND CREEP OF BERYLLIUM OXIDE. I. V. Shishkov, P. P. Budnikov, and P. L. Volodin. p.225-43 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. I." Vienna, International Atomic Energy Agency, 1963. (In Russian)

Experimental studies were made on the processes of sintering, recrystallization, and high-temperature creep of beryllium oxide, and on the effect on these processes of adding $UO_2$, $ZrO_2$, $Al_2O_3$, and MgO in amounts up to 1%. It was found that–in the temperature range of 1300–1900°C–the nearer the temperature of the experiment approaches the eutectic temperature in the BeO-admixture system, the greater is the increase in the rate of the processes in question. Of all the admixtures examined, magnesium oxide exercised the greatest effect. An equation is given representing the bend deformation of specimens at the steady creep stage. It is shown that creep rate grows with decrease in grain size in the structure, a phenomenon linked with recrystallization of the specimens in the course of creep testing. Another equation shows the relationship between creep rate and porosity. Data on the creep of polycrystalline specimens are used to calculate the coefficients of autodiffusion D in beryllium oxide. The temperature relationship D gives a low autodiffusion activation energy, of 70 kcal/Mole in the case of pure BeO. The values for D were close to one another, but differ by three orders of magnitude from the values calculated on the assumption of deformation through viscous slip along the grain boundaries. This indicates that in the process under consideration the volume diffusion of vacancies in the BeO lattice is the predominant mechanism. However, with a drop in temperature the role of boundary diffusion gains is importance. The results obtained were compared with data in the literature. (auth)

**7188** CARBIDES AS REACTOR FUELS: PREPARATION FROM OXIDES AND SINTERING CHARACTERISTICS. R. Ainsley, B. R. Harder, N. Hodge, R. G. Sowden, D. B. White, and D. C. Wood (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.349-76 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. I." Vienna, International Atomic Energy Agency, 1963.

Studies were made on the preparation of uranium, plutonium, and (U,Pu) carbides by the direct reduction of oxides with carbon in vacuo over the temperature range 1250–1900°C. Particular attention was paid to the kinetics and mechanism of the reactions, and to the effects of particle size and the mode of preparation of the oxides. Intermediate solid species were identified by quenching reacting mixtures rapidly from high temperature. Plutonium-bearing vapor species evolved at temperatures above 1450°C were condensed and estimated. The carbides produced from oxides were sintered to high densities (>95% of theoretical value) in various gas atmospheres and in vacuo. (auth)

**7189** STABILIZATION OF URANIUM MONOCARBIDE AND PRODUCTION OF SINGLE-PHASE CARBIDE. J. Van Geel and J. J. Huet (CEN, Mol, Belg.). p.385-400 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. I." Vienna, International Atomic Energy Agency, 1963. (In French)

To obtain single-phase uranium carbide, uranium carbide with 3.5 to 8 wt % of carbon was subjected to arc melting in a mixed argon–nitrogen atmosphere and a mixed argon–air atmosphere. The carbon and nitrogen contents of the final product were checked and found to depend on the partial pressure of nitrogen and oxygen. As a result of melting in an argon–nitrogen atmosphere, the carbide becomes impregnated with nitrogen. The carbon content also increases, as a result of contamination by the graphite electrode. By this process, a sub-stoichiometric carbide could be made stoichiometric. Melting in a mixed argon–nitrogen–oxygen atmosphere brings about a decrease in the carbon content as a result of a reaction between the carbides and the oxygen. The nitrogen content also increases. The nitrogen reacts with the free uranium to form uranium mononitride, which passes in solution into the uranium monocarbide. Thus, the melting of uranium carbides in the presence of oxygen and nitrogen yields a single-phase uranium carbonitride. (auth)

**7190** PREPARATION OF IMPERVIOUS PYROLYTIC CARBON COATINGS AND APPLICATION TO DISPERSED FUELS. A. Auriol (Battelle Memorial Inst., Geneva), C. David, A. Fillâtre, G. Kurka, E. Le Boulbin, and J. Rappeneau. p.519-42 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. I." Vienna, International Atomic Energy Agency, 1963. (In French)

A method of depositing pyrolytic carbon, which adheres well to a graphite support and is gas-tight, was developed and the physical properties of the deposit were evaluated. The fluidized bed technique was used in applying this method of coating to fissile granules of uranium oxide and uranium carbide. After explaining the conditions for coating the granules, their macrostructure, microstructure, and permeability were examined. Their behavior at high temperature was investigated with a view to using them in a reactor. (auth)

**7191** THE SINTERING OF U–C AND (UPu)–C. L. E. Russell and J. D. L. Harrison (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.543-61 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. I." Vienna, International Atomic Energy Agency, 1963.

It was found that powders prepared by the arc melting of monocarbides of uranium and uranium–plutonium alloys can be sintered to a high density in pure argon at temperatures between 1500 and 1600°C. To do this it is necessary to minimize the reaction of the fine carbide powders needed for sintering with oxygen and water vapor. Variations in carbon content between 4.0 and 5.3 wt % and of PuC content between 0 and 15 mole % have no significant effect on the final sintered density, which is usually greater than 13 g/cm$^3$. The preparation of U–C and $(U_{0.85}Pu_{0.15})$–C was carried out by reacting granules of $MO_2$ and carbon in flowing argon atmospheres at 1500–1600°C. Pellets pressed from carbides were sintered to high densities at 1550°C in argon and had oxygen contents of ~0.2 wt %. Carbides formed by this process, and having a large content of oxygen, sintered to a much higher density than did fine carbide powders that had picked up an equivalent amount of

oxygen as a result of exposure to atmospheres containing oxygen or water vapor. (auth)

**7192** IMPROVEMENTS IN OR RELATING TO URANIUM ALLOYS. (to Commissariat a l'Energie Atomique). British Patent 943,942. Dec. 11, 1963. Priority date July 21, 1961, France.

A method is given for preparing U–Mo alloys of 1 to 3% Mo content, which are suitable for use as a fuel in reactors. The method comprises fusing the metals together under vacuum in a graphite crucible covered with an alumina or calcium zirconate cement, pouring the molten alloy into molds to produce bars or tubes, and cooling the cast alloy to the ambient temperature at a rate of 10 to 80°C/minute. The resulting microstructure is very fine, with a grain size of 20 to 80 $\mu$, and the properties are superior to these of U. Moreover, since the Mo content is low, natural U may be used. (D.L.C.)

**7193** IMPROVEMENTS IN OR RELATING TO METHODS FOR PROCESSING FILTER TUBES. Michel Eudier and Daniel Massignon (to Commissariat a l'Energie Atomique). British Patent 944,319. Dec. 11, 1963. Priority date Nov. 16, 1960, France.

A method is given for processing filter tubes of sintered metal for the purpose of fixing them to another element such as a supporting plate or an adjacent filter tube. This method is especially applicable to the case where a microporous layer is deposited on the internal surface of the macroporous tube. The method comprises compacting a terminal portion of the tube, annealing the compacted portion in a reducing atmosphere, and finally securing the tube to a support element by a part of the compacted portion. (D.L.C.)

**7194** IMPROVEMENTS IN OR RELATING TO THE EXTRUSION OF METALS. Philip Bernard Eyre (to United Kingdom Atomic Energy Authority). British Patent 944,949. Dec. 18, 1963. Filed Nov. 21, 1961.

An apparatus is designed for the extrusion of metal tubes with longitudinal external fins. The apparatus comprises a container, a die, a mandrel projecting axially through the die bore, and a series of fin-forming rolls arranged around the end of the mandrel. The use of the apparatus in extruding Be tubes is described. (D.L.C.)

**7195** IMPROVEMENTS IN OR RELATING TO PROCESSES FOR MANUFACTURING TUBULAR BODIES OF COMPACT AND IMPERMEABLE GRAPHITE. (to Societe le Carbone-Lorraine). British Patent 945,256. Dec. 23, 1963. Priority date June 1, 1959, France.

A method for manufacturing tubular bodies of impermeable graphite comprises forming a tubular deposit of pyrolytic graphite on a graphite rod support with a smooth surface, and separating the deposit from the support by pressing or extrusion. Several ways of obtaining the smooth surface on the rod are described. (D.L.C.)

**7196** IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL COMPOSITIONS. Lewis Eric Russell and Brian Riley (to United Kingdom Atomic Energy Authority). British Patent 945,726. Jan. 8, 1964. Filed Oct. 2, 1961.

A method for preparing a fuel cermet in which a fissile metal oxide is dispersed in an iron matrix is described. A mixture of iron oxide and uranium dioxide or plutonium dioxide is heated to melt a substantial proportion of the mixture. The resultant mass is crushed. The iron oxide content is reduced to metallic iron and a compact formed of the iron and fissile metal oxide. (M.C.G.)

**7197** IMPROVEMENTS IN OR RELATING TO BRAZING END CLOSURES TO TUBULAR MEMBERS. Henry Lloyd and Harold Ralph William Cobb (to United Kingdom Atomic Energy Authority). British Patent 946,344. Jan. 8, 1964. Filed June 13, 1961.

A method of sealing the end of a tube was developed, especially for brazing an end cap to a nuclear fuel can, so that the tendency of the braze metal to emerge from the joint surfaces is minimized. A capillary film of braze metal is produced between the tube and the end closure to form a joint. The film is interrupted by spacing the end closure and the tube apart at each end of the joining surface a distance insufficiently small to maintain the capillary film. (M.C.G.)

**7198** SINTERING PROCESSES. Ronald Andrew Knight (to United Kingdom Atomic Energy Authority). U. S. Patent 3,115,408. Dec. 24, 1963. Priority date Dec. 22, 1958, Great Britain.

A method of producing a substantially pure Be tube is patented. Be powder in an uncompacted state is placed in a mold around a Cu core. The mold is heated to a temperature of 930 to 1030°C and maintained at that temperature long enough for the Be to become cohesive and self-supporting. The temperature is then raised to 1100 to 1200°C. The Cu core melts and can be withdrawn from the mold, and the higher temperature is maintained until the Be is completely sintered. (M.P.G.)

## Properties and Structure

*Refer also to abstract 7458.*

**7199** (AD-414490) DEVELOPMENT OF FINE-DIAMETER HIGH-PURITY WIRE FROM ZONE-REFINED BERYLLIUM. Technical Report No. 299-236. Final Report. A. G. Gross, Jr. and R. G. O'Rourke (Brush Beryllium Co., Cleveland). Jan. 1963. Contract NOw 62-0067-c. 14p.

Wires from zone-refined crystal D were tensile tested at room temperature. These wires were tested in the as-drawn-with-lubricant condition. Tensile properties of the wire from crystal D were determined as a function of wire-drawing strain. These tensile data were compared to similar data for commercially pure beryllium wire. It was found that, on the average, the zone-refined beryllium work-hardened at about the same rate as did commercially pure beryllium. The room temperature strength level of the zone-refined material was about half that of the commercially pure wire. Room temperature ductility in the as-drawn condition was not very purity-sensitive. (auth)

**7200** (AERE-X/M-100) NOTE ON SOME ALLOYS OF GOLD AND URANIUM. Report M2187. N. P. Allen (Gt. Brit. National Physical Lab., Teddington, Middx., England). 1952. 8p.

The system Au–U was investigated in some detail. Au and U were found to form several intermetallic compounds of possible composition UAu, $UAu_2$, $UAu_3$, $UAu_4$, and $UAu_5$. No immiscibility gaps were encountered, in contrast with Cu–U and Ag–U. At least three eutectic points occur in the Au–U system. (D.L.C.)

**7201** (ASD-TDR-63-597) THERMAL PROPERTIES OF REFRACTORY ALLOYS. J. C. Hedge, C. Kostenko, and J. I. Lang (Illinois Inst. of Tech., Chicago. IIT Research Inst.). June 1963. Contract AT33(657)-8810. 128p. (AD-424375)

The objective of this program was the determination of the thermal properties of fifteen selected refractory materials. The materials investigated were boron carbide, zirconium nitride, spinel, beryllium oxide, six niobium alloys, three tantalum alloys, and two molybdenum alloys.

The thermal conductivity, specific heat, and linear thermal expansion were measured from room temperature to the melting point, or 5000°F, whichever was lower. (auth)

**7202** (CEND-199) THE DEVELOPMENT AND TESTING OF $UO_2$ FUEL SYSTEMS FOR WATER REACTOR APPLICATIONS. Progress Report, Period Ending, September 30, 1963. W. P. Chernock, C. E. Burdg, M. G. Andrews, E. I. Veil, and W. J. Mordarski (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.). Nov. 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-2863. 50p. (EURAEC-903)

Deficiencies in the design of the thermal conductance test apparatus precluded measurements under desired maximum thermal conditions. The maximum heat flux in the test element was limited by a high temperature drop through the cast alloy used as a heat transfer medium from the cladding to the water jacket. In addition, hot spots developed as a result of the characteristics of the electrical resistivity vs temperature for the tungsten heater rod. Tantalum or tungsten–rhenium heater rods are being substituted for tungsten. The first run with a tantalum heater rod indicated a marked improvement in uniformity of axial temperature. Replacement of the cast alloy with water cooling directly on the cladding permitted achievement of fuel centerline temperatures in the desired range. In previous work, the "Tangent Modulus Criterion" was established for predicting collapse pressure in stainless steel tubing for diameters up to 0.75 in. and thickness-to-diameter ratios up to 0.15. The useful range of application of this collapse criterion is being extended to tubing with diameters up to 1.5 in. The influence of varying L/D, out-of-roundness, and Poisson's ratio is being assessed as an aid in data reduction. Stainless steel tube specimens with a 0.750 in. outside diameter are being collapsed in order to evaluate the variation in collapse pressure with changes in L/D. Results of L/D evaluations to date indicate that tubes with an L/D as low as 11 represent infinite tube conditions for a 0.750 in. outside diameter. A pressure vessel body for collapse testing is being purchased with a length capacity equal to that required by even the most adverse conclusions regarding the L/D value which represents an infinite tube. The differential thermal elongation test on the projection welded, 37-rod, stainless steel cluster was terminated after 3000 temperature reversals with tube-to-tube temperature differentials of 42°F. Weld fractures were found, on visual inspection, after 2000 temperature reversals. The temperature differential used was greater than twice that anticipated in an operating water-cooled power reactor, and the number of cycles achieved prior to the first visual indication of weld failures was almost ten times that anticipated for one core lifetime. Stress calculations and metallographic examination of weld regions were completed. The cause of weld failure was attributed to cyclic stresses induced by thermal elongation. Another thermal cycle test is being planned with reference temperature differentials between adjacent tubes and with inspection of weld regions every 300 to 500 cycles. (auth)

**7203** (D2-35105) EVALUATION OF Cb-752, COLUMBIUM ALLOY (Cb–10%W–2.5%Zr). Roy G. Baggerly and R. T. Torgerson (Boeing Co., Seattle). Mar. 1963. 55p.

An evaluation of Haynes-Stellite Nb-752 niobium alloy (Nb–10W–2.5Zr) was conducted to establish its potential as a structural material for reentry vehicles. Properties which were investigated include tensile properties to 3000°F, creep properties to 3000°F, formability, ductile-brittle transition temperature, fusion welding, protective coating, oxidation resistance, and emittance. Testing was conducted on 0.010- to 0.035-in. sheet from three heats of material. The evaluation indicates Nb-752 alloy has potentially useful strength in the temperature range of 2000 to 3000°F. The alloy displayed good formability at room temperature, sub-zero transition temperature, and good fusion weld strength and ductility. Principal problem areas disclosed were inadequate coating thickness with current Disil coating process and the brittle behavior of Disil coated welds. It is concluded that Nb-752 alloy is a promising high-strength, second generation niobium alloy with potential advantages for structures of current and future reentry vehicles. It is recommended that riveted structures rather than welded structures should be considered for Nb-752 alloy due to the low-temperature brittleness of coated fusion welds. (auth)

**7204** (DMIC-Memo-170) CREEP OF COLUMBIUM ALLOYS. E. S. Bartlett and J. A. VanEcho (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). June 24, 1963. Contract AF33(616)-7747. 92p. (AD-424097)

Existing creep data for Nb alloys are compiled and reviewed with respect to their merits and limitations for time-dependent structural service. (D.L.C.)

**7205** (EUR-433.d) EINFLUSS UNTERSCHIEDLICHER KALTVERFORMUNGEN AUF DIE MECHANISCHEN EIGENSCHAFTEN UND DEN DISPERSIONSGRAD VON SINTERALUMINIUM. (Influence of Various Cold-Working Processes on the Mechanical Properties and Degree of Dispersion of Sintered Aluminium Products). E. G. Hess (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1963. 14p.

As-extruded dispersion-hardened aluminium (SAP) containing 4 to 14% $Al_2O_3$ as strengthening phase is cold-worked by drawing, rolling, and swaging. The maximum deformability (limited by resistance to recrystallization) and the influence of cold work on the dispersion structure and the mechanical properties are investigated. With increasing cold-work, three ranges with different deformation mechanisms can be observed: (1) work-hardening of the matrix; (2) refinement of the banded structure originating from the extrusion; and (3) considerable dispersion improvement by cracking and distribution of $FeAl_3$ inclusions and oxide-agglomerates in the range of the highest reductions. (auth)

**7206** (GAT-T-1121) THE APPLICATION OF ULTRAMICROTOMY TO ELECTRON METALLOGRAPHY AND DIFFRACTION STUDIES OF ALUMINUM ALLOYS. F. C. Steinbach, D. K. Landstrom, and K. E. Beu (Goodyear Atomic Corp., Piketon, Ohio). Aug. 28, 1963. Contract AT(33-2)-1. 15p. (CONF-168-1)

From 21st Annual Meeting of the Electron Microscope of America, Denver, Aug. 1963.

The ultramicrotome with a diamond knife is used to cut slices of metals and alloys as thin as 100 Å for electron-microscopic examination. Using the ultramicrotome and the proper technique, it is possible to study complex minor phases and their structure. Micrographs of binary Al alloys with Cu, Mg, Mn, Fe, and Si and of a complex Al casting alloy 214X are presented which compare the ultramicrotome technique with optical microscopic and electron microscopic (replica) techniques. (D.L.C.)

**7207** (HW-77954(p.3.55-83)) PLUTONIUM PHYSICAL METALLURGY. R. D. Nelson, F. E. Bowman, G. E. Miller, C. R. Becker, V. C. Asmund, and H. E. Kissinger (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

T-T-T curves of the $\gamma \rightleftharpoons \beta \rightleftharpoons \alpha$ transformations of plutonium containing less than 250 ppm impurities by weight were obtained. The curves are similar to corresponding ones derived earlier from poorer quality metal but are shifted to lower times. The veining which is frequently observed on the surface of plutonium was identified as bands of columnar grains, which form in the early stages of the $\beta \rightarrow \alpha$ transformation. Sharp discontinuities were observed on the $\delta \rightarrow \gamma$ isothermal reaction curves of metal known to contain certain impurities. The volume increases associated with each of these discontinuities were very rapid, and their number and magnitude increased with decreasing temperature. The incubation time of the $\gamma \rightarrow \beta$ transformation was two to three orders of magnitude greater in this metal than in high purity plutonium. Preliminary studies on the weakening of plutonium under stress during transformation showed that transformation strain is a significant portion of the total strain. Transformation strain increased with the applied stress and was greater for the $\alpha \rightarrow \beta$ transformation than for the $\beta \rightarrow \alpha$ transformation. Transformation strain also increased as the initial grain size decreased and was transformation rate dependent. Fractography, the study of fracture interface by metallographic examination, was initiated. Tensile testing of aluminum-stabilized delta plutonium is in progress to determine the existence of the Portevin-Le Chatelier effect. Despite the apparent lack of ductility exhibited by plutonium under tensile loading, it was established that this material can be deformed severely (90% reduction) by flat rolling in the temperature range of 25 to 70°C (76 to 158°F). Roll pass schedules involving reductions of up to 50% per pass were successfully applied with a minimum of edge cracking. It appears that the rolling characteristics improve as the reduction per pass is increased. Preliminary x-ray diffraction data from the rolled material indicated major changes in the crystallographic orientation as compared with the as-cast structure. There was, however, no indication of line broadening that would suggest the presence of residual stresses and/or extensive grain fragmentation. This observation was supported by the absence of significant changes in hardness after deformation at the lowest temperatures investigated (about 25°C(76°F)). This suggests that both the recovery and recrystallization temperatures are usually low. (auth)

**7208** (HW-77954(p.4.85-8)) DAMAGE MECHANISMS. F. A. Smidt and B. Mastel (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Data are reported for two tensile tests of zone-refined iron obtained from Battelle Memorial Institute and the results compared with previous tests of zone-refined iron from other sources. Foils of Johnson-Matthey iron were deformed in an Instron testing machine and examined by electron transmission microscopy. A foil strained 5% showed many dislocation tangles and a few loops but no pile-ups at grain boundaries. (auth)

**7209** (HW-77954(p.5.18-19)) CHARGING OF ZIRCALOY-2 WITH HYDROGEN BEYOND THE TERMINAL SOLUBILITY. R. E. Westerman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Data are reported on the continuing study of the mechanism by which zirconium is charged with hydrogen in excess of solubility. The rate of transfer of hydrogen from an external case to the sample interior under thermal cycling from room temperature to 400°C is under investigation and appears to be a slow but measurable process. (auth)

**7210** (HW-77954(p.5.27-9)) ELECTRICAL RESISTANCE PROPERTIES OF ZIRCONIUM CORROSION PRODUCT. R. S. Hope (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

In-reactor measurements of the electrical resistance of oxide films on zirconium indicated an immediate decrease in film resistance at reactor startup. (auth)

**7211** (HW-78962(p.3.35-60)) PLUTONIUM PHYSICAL METALLURGY. R. D. Nelson, F. E. Bowman, G. E. Miller, C. R. Becker, and H. E. Kissinger (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The creep strain of alpha and beta plutonium at a series of temperature and compressive stress conditions was determined. The normal strain and the length change due to transformation were compared to the total strain associated with plutonium undergoing transformation. Transformation creep as a function of transformation rate, compressive stress, and temperature was derived. Results indicated that $\alpha \rightarrow \beta$ transformation creep is appreciable and is approximately a linear function of applied stress. Physical damage associated with repeated cycling between temperatures bracketing phase transformations, as revealed by density changes, is dependent on the number of cycles, the temperature, and the particular allotropes involved in the transformation. The effect of prior heat treatment and beta plastic deformation on subsequent $\beta \rightarrow \alpha$ transformation led to the tentative conclusion that this transformation is martensitic. The crystallographic relationships existing between as-cast, as-alpha-rolled, and as-alpha-annealed plutonium, as indicated by changes in x-ray line intensities and widths, were investigated. Although changes were apparent, it was not clear whether or not recrystallization occurs during or subsequent to the rolling operation responsible for the development of the observed texture. Microfractographic analysis of plutonium with different histories fractured at a variety of test temperatures was continued. (auth)

**7212** (HW-78962(p.6.1-10)) GAS LOOP DEVELOPMENT. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Samples of Haynes 25 tubing to be used in the model loop regenerative heat exchanger were found to be of good quality as indicated by fluorescent penetrant testing and metallographic examination. Studies showed that Hastelloy X containing plastic strain in the range of about 0 to 5% undergoes germinative grain growth when heat treated for 1 hr at 1177°C (2150°F). The design of the Mark I test section for the model gas loop was completed, components ordered, and construction started. A fabrication method incorporating stainless steel wire and mesh interior reinforcement was developed for the large castable Fiberfrax insulating blocks for the double-contained piping of the model gas loop. The computer program prepared for calculating interface temperatures, film drops, and heat losses for the double-contained pressure piping with insulation between pipes was expanded to include up to eight layers of alternative construction materials. A preliminary analysis indicated that water cooling as well as gas attemperator should be considered for reducing the temperature of the 1093°C (2000°F) helium leaving the ATR test section. The tensile specimen holder was redesigned to decrease the number of parts and to provide for easier assembly and disassembly. (auth)

**7213** (JINR-P-1440) ISSLEDOVANIE STRUKTUR METODOM DIFRAKTSII NEITRONOV NA IMPUL'SNOM BYSTROM REAKTORE (IBR). (Investigation of Crystal Structures by Neutron Diffraction Method with the Pulsed

Fast Reactor). V. V. Nitc (Nitts), Z. G. Papulova, I. Sosnowska (Sosnovska), and E. Sosnowski (Sosnovski) (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 12p.

A possibility of investigating the crystal structures was tested on the pulsed reactor of 1-kw mean power. Using the white incident beam, the energy spectrum of the neutrons scattered at the given angle was measured by the time of flight method. The latter yields considerable intensity and low background. The neutron diffraction diagrams for the powder samples of Al, Zn, ZnO allowed analysis of the structure with a good accuracy. The oxygen parameter of ZnO was found to be x = 0.374. (auth)

**7214** (NP-13431) DIELECTRIC CONSTANT AND LOSS MEASUREMENTS ON HIGH-TEMPERATURE MATERIALS. Technical Report 182. W. B. Westphal (Massachusetts Inst. of Tech., Cambridge. Lab. for Insulation Research). Oct. 1963. Contract AF33(616)-8353. 86p.

Measurement techniques for the frequency range $10^2$ to about $2.5 \times 10^{10}$ are discussed for temperatures to 1650°C. These include the use of bridges, resonant circuits, standing-wave methods, and resonant cavities. Data on crystals of $Al_2O_3$, $Cr_2O_3$, MgO, $LaAlO_3$, $Y_2O_3$; on multicrystalline bodies of $Al_2O_3$, BeO, MgO, $Mg_2SiO_4$, $Ta_2O_5$, ThO; on glass ceramics, silica glass, and BN are presented over smaller temperature and frequency ranges. Pyrolitic BN has a low loss tangent (0.0004 at 1375°C, $4.8 \times 10^9$ cps) and a low temperature coefficient of dielectric constant. Some aluminas and silicas exhibit loss tangents of ca. 0.0006 at 1000°C in the microwave region. Microwave losses are due partly to the charge transfer responsible for low-frequency conductivity and to the vibration spectra of infrared absorption. Both losses are increased by the addition of impurities. (auth)

**7215** (NP-13437) THE LATTICE PARAMETERS OF HIGH PURITY BERYLLIUM. Technical Report No. 149. K. J. H. Mackay (Tube Investments Research Labs., Hinxton Hall, Cambridge, England). July 24, 1962. 31p.

The lattice parameters of vacuum-distilled beryllium, of 99.9% purity, were determined from observations on a single-crystal flake, by means of the Kossel deficiency pattern produced in a divergent beam of monochromatic x rays. The values, which are accurate to ±0.01%, are $a_0 = 2.2858$ Å and $c_0 = 3.5843$ Å. The work described represents an extension of previous measurements made in this laboratory, in three respects—the purity level is known; better crystallinity and improved techniques have led to higher accuracy; and the calculations were simplified, without loss of precision. (auth)

**7216** (TID-19872) A STUDY ON THE NATURE OF ANNEALING TWINS. Report for the Period June 15, 1962 to September 15, 1963. J. R. Hancock, K. L. Keating, and D. J. Murphy (Arizona. Univ., Tucson. Coll. of Mines). Contract AT(11-1)-1040. 127p.

An investigation was made on the properties and phenomenological behavior of noncoherent twin boundaries in copper and copper-base alloys. The investigation has shown the importance of considering the three-dimensional character of annealing twins and of the twinning processes taking place, and the effect of time and temperature, on twinning frequency. Noncoherent twin boundaries were shown to be relatively high energy boundaries extending through a crystal in the form of loops, which, at elevated temperatures, may migrate in either direction parallel to coherent twin boundaries. Migration was observed to occur in a stepwise, discontinuous manner. Noncoherent twin boundaries were moved thermo-mechanically under conditions of severe abrasive deformation, in which case they resembled their counterparts in mechanical twins. (auth)

**7217** (TID-19877) [PROGRESS REPORT ON STRESS-STRAIN PROPERTIES OF BRITTLE MATERIALS]. Frank J. Digesu and C. D. Pears (Southern Research Inst., Birmingham, Ala.). Dec. 11, 1963. Contract AT(40-1)-2694. 16p.

The tensile properties of zirconium diboride–molybdenum disilicide (Boride No. 6) are reported for the hot pressed and for the pressed and sintered compacts at 70 to 3650°F. The properties of the brittle material are compared with alumina and other brittle materials. (N.W.R.)

**7218** (WADD-TR-60-782(Pt.XIX)) VAPORIZATION OF COMPOUNDS AND ALLOYS AT HIGH TEMPERATURES. PART XIX. MASS SPECTROMETRIC DETERMINATION OF THE DISSOCIATION ENERGY OF THE MOLECULES $Sc_2$, $Y_2$, $La_2$ AND YLa. G. Verhaegen, S. Smoes, and J. Drowart (Brussels. Université). Aug. 12, 1963. Contract AF61(052)-255. 8p.

The diatomic molecules $Sc_2$, $Y_2$, $La_2$, and YLa were identified mass spectrometrically in the vapors above condensed scandium, yttrium, lanthanum, and Y–La alloys, respectively. Their dissociation energies are $D_0^0(Sc_2) = 25.9 \pm 5$, $D_0^0(Y_2) = 37.3 \pm 5$, $D_0^0(La_2) = 57.6 \pm 5$, and $D_0^0(YLa) = 47.3 \pm 5$ kcal/mole. (auth)

**7219** (WADD-TR-61-72(Vol.XX)) RESEARCH AND DEVELOPMENT ON ADVANCED GRAPHITE MATERIALS. VOLUME XX. THE ELECTRIC AND MAGNETIC PROPERTIES OF PYROLYTIC GRAPHITE. G. Wagoner and B. H. Eckstein (National Carbon Co., Parma, Ohio). May 1963. Contract AF33(616)-6915. 25p.

A study was made of the electric and magnetic properties of a series of highly turbostratic pyrolytic graphite deposits. The diamagnetic susceptibility, Hall coefficient, and electron spin resonance g value are observed to have much larger magnitudes than corresponding measurements made on single crystals of graphite. The results are interpreted as being due to the turbostratic character of the deposit which brings about a decreased interaction between the randomly rotated graphitic planes. The overlap of the electron and hole bands is thereby reduced and as a first approximation one can interpret the results using the simple two dimensional model of Wallace. McClure's diamagnetism formula, which is based on the Wallace model, yields a maximum trace value of −39 emu/g. The largest observed value is −33.5 emu/g, a diamagnetism almost 50 per cent greater than the normal single crystal value of −22.8 emu/g. To obtain from theory the large variation of g shift and diamagnetism as a function of formation temperature, it is necessary that acceptors be present whose concentration decreases as the temperature of formation increases. Similar acceptors have been postulated by others to explain the properties of high temperature carbons. (auth)

**7220** (JPRS-22599) ALLOYS OF PLUTONIUM. S. T. Konobeevskii (Konobeyevskiy) and V. I. Kutaytsev. Translated from Issled. Aplavov Tsvetn. Metal., Akad. Nauk SSSR, Inst. Met., No. 4, 17-24(1963). 11p. (OTS-64-21207)

A survey is presented of the properties of Pu and its alloys. The physical properties of Pu are tabulated, and a thermogram and the magnetic susceptibility of Pu are shown graphically. The alloying properties of Pu with various elements are described. Phase diagrams are given for alloys of Pu with Li, Be, Mo, Zr, U, Al, and Fe. (D.L.C.)

**7221** REFRACTORY BORIDES. R. Thompson and A. A. R. Wood (Borax Consolidated Ltd., Chessington, Surrey, Eng.). Chem. Engr. (London), No. 166, CE51-6 (Mar. 1963).

A review is presented on the properties, fabrication, preparation and production, and applications of refractory borides. (P.C.H.)

**7222** THE USE OF GRAPHITE AT HIGH TEMPERATURES. A. R. Ford (Morganite Carbon Ltd., London) and A. E. White. Chem. Engr. (London), No. 166, CE61-8(Mar. 1963).

The high-temperature properties of graphite are discussed, with particular reference to the use as a containment material. The main high-temperature fields of usage for graphite are as a containment material, structural material, or a resistance heating element. (P.C.H.)

**7223** THERMAL EXPANSION AND CHANGE IN VOLUME OF URANIUM DIOXIDE ON MELTING. J. A. Christensen (General Electric Co., Pittsburgh). J. Am. Ceram. Soc., 46: 607-8(Dec. 21, 1963).

Thermal expansion and specific volume measurements were made on $UO_2$ at 1280 to 3100°C in intervals of 100 to 500°C. Radiographs taken at 3000°C (200°C above the melting point) and at room temperature after cooling qualitatively illustrate the shrinkage that occurred on solidification. The density of the solid at 2800°C was 9.67 ± 0.13; that of the liquid at 2800°C was 8.74 ± 0.16. The decrease in density on melting was 9.6%. Molten $UO_2$ had a coefficient of linear expansion of $3.5 \times 10^{-5}$ in. per in. °C between 2800 and 3100°C. Expansion data from 0 to 2800°C were used to derive an empirical equation for specific volume as a function of temperature: $V_T = V_0(1 + 9 \times 10^{-6} T + 6 \times 10^{-9} T^2 + 3 \times 10^{-12} T^3)$ where $V_T$ = specific volume (g per $cm^3$) at temperature T, $V_0$ = specific volume at 0°C, and T = temperature (°C). (P.C.H.)

**7224** HIGH-TEMPERATURE HEAT CONTENT OF HAFNIUM. Donald T. Hawkins, Marc Onillon, and Raymond L. Orr (Univ. of California, Berkeley). J. Chem. Eng. Data, 8: 628-9(Oct. 1963). (UCRL-10729)

High-temperature heat contents of hafnium were measured over the temperature range 298 to 1346°K, using a diphenyl ether calorimeter. The results are well represented by the analytical expression: $H^0_T - H^0_{298.15} = 5.607T + 0.911 \times 10^{-3}T^2 - 1753$. Smoothed values of the thermal properties of hafnium, $H^0_T - H^0_{298}$, Cp, $S^0_T - S^0_{298}$, and $(F^0_T - H^0_{298})/T$, were derived and are tabulated at even 100° intervals. (auth)

**7225** HIGH-TEMPERATURE ELECTRICAL CONDUCTIVITY IN THE SYSTEMS CaO–$ZrO_2$ AND CaO–$HfO_2$. H. A. Johansen and J. G. Cleary (Westinghouse Electric Corp., Pittsburgh). J. Electrochem. Soc., 111: 100-3 (Jan. 1964).

The a-c electrical conductivity of CaO–$ZrO_2$ and CaO–$HfO_2$ was measured from 800 to 2000°C. The two systems are similar. The conductivity maximum was found near 12 mole % CaO in both zirconia and hafnia. (auth)

**7226** FERRO-ALUMINUM ALLOYS WITH ADMIXTURES OF RARE AND RARE-EARTH METALS. E. M. Savitskii, I. V. Burov, V. F. Terekhova, and V. I. Kashin. Met., Metalloved., Fiz. Khim. Metody Issled., No. 13, 163-70(1963).

An investigation was made on the effects of the addition of Ce, Mo, Ta, and/or Zr on the mechanical properties at room and elevated temperatures, the resistance to oxidation and pitting, and the magnetic properties of Fe–Al alloys containing 15 to 18% Al. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7227** HYDROGENATION OF U–UC ALLOYS. G. Baudin, J. Besson, P. Blum, and J. Chevallier (Centre d'Etudes Nucléaires, Grenoble, France). J. Nucl. Mater., 10: 173-81(Nov. 1963). (In French)

The hydrogenation of free uranium in U/UC alloys was examined with regard to kinetics and yield. When the free uranium content is 45–50% (which entails the maximum area of U/UC interface), the rate of hydrogenation is highest at 95°C. So long as the free uranium content exceeds 15–18% (the lower limit for a continuous uranium phase) the yield attains 100%. (auth)

**7228** THERMAL MIGRATION OF HYDROGEN IN ZIRCONIUM–URANIUM–HYDROGEN ALLOYS. U. Merten, J. C. Bokros, D. G. Guggisberg, and A. P. Hatcher (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Nucl. Mater., 10: 201-8(Nov. 1963).

The migration of hydrogen under a thermal gradient was examined in zirconium–uranium–hydrogen alloys of interest as reactor fuel-moderator materials and in certain binary zirconium–hydrogen alloys. No detectable hydrogen redistribution was observed in the alloys having H : Zr atom ratios of about 1.6. In alloys having H : Zr atom ratios of less than 1.4, rapid hydrogen migration toward the cold portions of the samples was observed. (auth)

**7229** DILATOMETRIC ANOMALIES OF BERYLLIUM SINTERED IN ARGON. P. Bastien and P. Pointu (Ecole Centrale des Arts et Manufactures, Paris). J. Nucl. Mater., 10: 248-50(Nov. 1963). (In French)

During dilatometric analysis of Be of different grades, a consistent anomaly in a supplementary dilatation able to attain $5 \times 10^{-3}$ between 850 and 950°C was verified in the case of beryllium sintered under argon then forged and rolled. The amplitude of the anomaly varies in the same sense as the heating velocity (cycles of 4, 40, and 200°C/hr). It increases in general with the duration of preliminary heat under vacuum below 815°C (annealing accomplished at 450 to 900°C from 1 to 300 hr). (P.C.H.)

**7230** CRYSTALLOGRAPHIC ANGLES FOR ALPHA PLUTONIUM. L. T. Lloyd and L. J. Nowicki (Argonne National Lab., Ill.). J. Nucl. Mater., 10: 253-7(Nov. 1963).

Standard 010 stereographic projections of the angles between planes and the angles between directions were prepared for the crystal structure of alpha plutonium in order to provide means of interpreting Laue x-ray patterns and x-ray measurements of preferred orientation. Lattice constants of the monoclinic structure (space group $P2_1/m$) were used for the calculations. A partial listing of the angles wherein the absolute value of each index does not exceed three is tabulated. (P.C.H.)

**7231** FATIGUE TESTING OF UNALLOYED PLUTONIUM. H. R. Gardner (General Electric Co., Richland, Wash.). J. Nucl. Mater., 10: 258-60(Nov. 1963).

A pneumatic apparatus was developed for room temperature fatigue testing of as-cast Pu at a frequency of 270 cycles/sec. The fatigue testing fixture operates on the principle used to vibrate the reeds in a harmonica. The results of fatigue tests on as-cast Pu specimens showed that fatigue cracks initiated at two positions. In one, a crack initiated at a corner of the specimen and this was characteristic of crack propagation in the majority of the specimens. In the other the crack initiated on the surface of the specimen. (P.C.H.)

**7232** GRAIN-BOUNDARY PRECIPITATES IN OVER-SINTERED $UO_2$. I. Amato and R. L. Colombo (FIAT, Turin). J. Nucl. Mater., 10: 261-2(Nov. 1963).

Studies were made on grain-boundary precipitates in over-sintered $UO_2$ pellets. Microhardness impressions

showed that a second phase, medium-gray in color, is much harder than the $UO_2$ matrix (1300–1600 versus 700 kg/mm$^2$). The fact that the carbon content of the pellets (250 ppm), probably deriving from decomposition of the organic additives, was much higher than the nitrogen content (10 ppm) suggests that the grey phase is $U_2C_3$. (P.C.H.)

**7233** INVESTIGATIONS IN THE SYSTEM HAFNIUM–TANTALUM–CARBON. E. Ruby and H. Nowotny. Monats. Chem., 94: 507-17(1963). (In German)

Pressure-sintered specimens containing 0 to 80% Ta, 0 to 50% Hf, and 0 to 60% C at 1850°C were vacuum-annealed and quenching, microscopic, and x-ray studies were made on phase equilibria in the ternary system Hf–Ta–C. The results are represented in terms of an isothermic section of the phase diagram; the free energy of formation of carbide phases was computed. (TCO)

**7234** AN EVALUATION OF THE TERNARY SYSTEM THORIUM–SILICON–GERMANIUM. P. Stecher, F. Benesovsky, and H. Nowotny. Monats. Chem., 94: 549-64(1963). (In German)

Lattice parameters were measured for cold pressed and sintered or hot pressed Th–Si–Ge powder specimens by x-ray measurements and the melting points were established by melting tests. The binary and ternary phase diagrams are given and the crystal structures formed were analyzed. (TCO)

**7235** NEPTUNIUM, PLUTONIUM, AND TRANSURANIAN ELEMENTS. Nature (Paris), No. 3340, 336-7(Aug. 1963).

A review is given of the atomic, chemical, physical, and mechanical properties and oxidation resistance of Np, Am, and Cm. Application in nuclear reactors is also discussed. (TCO)

**7236** NITROGEN RELEASE FROM $UO_2$ PELLETS AT ELEVATED TEMPERATURES. Harry M. Ferrari (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 17: 503-12(Dec. 1963).

The mechanism and kinetics of nitrogen release from $UO_2$ pellets containing high nitrogen impurities were investigated at elevated temperatures. A combination of metallographic and x-ray analyses showed that nitrogen present in the $UO_2$ exists as a second phase in the form of uranium nitrides. The kinetics of nitrogen release were measured at temperatures of 1000, 1200, 1400, and 1600°C and the mechanism of release was determined to be controlled by the diffusion of nitrogen through the $UO_2$ lattice. The variation in nitrogen pressure upon heating a $UO_2$ fuel element to elevated temperatures was studied. The data showed that a reversible equilibrium pressure-temperature relationship did not exist between the nitrides in the $UO_2$ and the nitrogen gas above it as occurs with pure uranium nitrides. The quantity of nitrogen that will be released in a $UO_2$ fuel element is determined by the kinetics of diffusion of nitrogen through the $UO_2$ lattice and may be computed for any given fuel element design utilizing a diffusion model similar to one used for computing release of fission gases. (auth)

**7237** IMPLICATIONS OF U–N PHASE SYSTEM FOR UN FUEL. Nucleonics, 22: No. 1, 64(Jan. 1964).

Phase studies were made on the U–N system in order to study properties of UN. From the phase diagrams it was concluded that a minimum nitrogen pressure of 2.5 atm is required to produce cast UN. At lower pressures it is impossible to saturate the uranium liquid phase to the UN composition. It is also possible to produce UN by the decomposition of $U_2N_3$ at fairly low temperatures in a pumping system that will maintain a reasonable vacuum. However, because the kinetics are extremely slow at lower temperatures, 1000°C is the minimum reasonable temperature for a production process. (P.C.H.)

**7238** EFFECT OF PRESSURE AND TEMPERATURE ON THE ELECTRICAL RESISTANCE OF ELEVEN RARE-EARTH METALS. R. A. Stager and H. G. Drickamer (Univ. of Illinois, Urbana). Phys. Rev., 133: A830-5(Feb. 3, 1964).

The electrical resistance of eleven rare-earth metals was measured as a function of pressure to over 500 kbars at 77 and 296°K. Appropriate isobars between 77 and 296°K were also obtained. The electronic structure of rare-earth metals is complex with the 4f and 5d atomic levels relatively close, and both atomic levels split by the crystal field. A wide variety of transitions are observed, many of which must be electronic in character, i.e., they must involve the lowering in energy of one electronic energy band vis-à-vis another with increasing pressure and decreasing interatomic distance. These data should provide a partial basis for a theoretical treatment of energy bands in the rare-earth metals. (auth)

**7239** CALCULATION AND DETERMINATION OF LIQUIDUS CURVES IN OXIDIZING SYSTEMS $La_2O_3$–MgO, $Y_2O_3$–MgO, $Sc_2O_3$–MgO. S. G. Tresvyatskii and L. M. Lopato (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, Ukrainian SSR). Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 5, 28-32(Sept.-Oct. 1963). (In Russian)

It is shown that the fusibility curves in the systems $La_2O_3$–MgO, $Y_2O_3$–MgO, and $Sc_2O_3$–MgO are eutectic and close to the values calculated by the equations for ideal solutions. In all three systems a composition close to 1:1, and not that of the spinel type, corresponds to the formation of fine-grained eutectics. This fails to confirm the presence of the flat maximum previously found by others. (auth)

**7240** ON THE CONNECTION OF CERTAIN PROPERTIES OF TRANSITION METALS CHARACTERIZING THE DURABILITY OF INTERATOMIC BONDS WITH THEIR ELECTRON STRUCTURE. Z. I. Tolmacheva and V. N. Eremenko (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, Ukrainian SSR). Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 5, 33-42(Sept.-Oct. 1963). (In Russian)

On the basis of an analysis of the changes of certain physical and thermodynamic properties of transition metals in connection with their positions in the periodic system of elements, it is shown that an increase in the durability of interatomic bonds in each subgroup of transition metals with an increase in the order number is due to a considerable extent to the covering of electron clouds of ions. (auth)

**7241** WETTING OF CARBIDE ALLOYS Nb–VC AND Nb–TiC WITH NICKEL. V. I. Tumanov, V. F. Funke, and L. I. Belenkaya. Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 5, 43-6(Sept.-Oct. 1963). (In Russian)

The wetting of binary carbide alloys NbC–TiC and NbC–VC with nickel was studied by the resting drop method. The carbide alloy samples were made by hot pressing. In the investigated systems the marginal angle of wetting has a minimum value with a content of the components of about 50 mole %. The possible mechanism of wetting of carbide systems by iron group metals, taking into account changes in the electric resistivity of alloys, is discussed. (auth)

**7242** ELECTRONIC PROPERTIES OF THE ACTINIDE METALS AT LOW TEMPERATURES. G. T. Meaden (Oxford Univ.). Proc. Roy. Soc. (London), Ser. A, 276: 553-70 (Dec. 17, 1963).

The electric resistivity and thermoelectric power of

thorium, uranium, neptunium, and plutonium were measured down to liquid-helium and liquid-hydrogen temperatures. The resistivities are relatively high, especially those of neptunium and plutonium, while all the thermoelectric powers show complicated temperature relations. The temperature dependence of the resistance of $\alpha$-plutonium is abnormal, being characterized by a small negative temperature coefficient above 105°K and a large positive coefficient below this temperature. Some plutonium rich $\delta$-Pu + Al alloys also show similar behavior. An explanation in terms of spin-disorder effects seems most reasonable, and it is suggested that both $\alpha$- and $\delta$-plutonium may be antiferromagnetic. The resistance–temperature curves of uranium and neptunium also are unusual in that the positive temperature coefficients decrease monotonically with rising temperature. Possible reasons for this were discussed. (auth)

**7243** STRUCTURE OF SOME INTERMETALLIC COMPOUNDS OF YTTRIUM. PART 2. COMPOUNDS WITH Al, Ga, In, Pb, AND Sn. Giacomo Bruzzone and Assunta Ferro Ruggiero. Rendiconti, 33: 465-71(Dec. 1962). (In Italian)

Intermetallic compounds of yttrium with Al, Ga, In, Pb, and Sn were subjected to x-ray analysis and micrography to determine their structure, phase composition, interatomic distances, and lattice parameters. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7244** PRECIPITATION OF VACANCIES IN METALS. G. Thomas and J. Washburn (Univ. of California, Berkeley). Rev. Mod. Phys., 35: 992-1011(Oct. 1963).

Clustered vacancies, the various factors involved in their precipitation, annihilation and the manner in which they induce hardening are considered. A guide for the analysis of dislocation loops formed from collapsed clustered point defects is included. A summary of the kinds of defects observed by electron microscopy in quenched and aged metals is given. (C.E.S.)

**7245** THE ELECTRICAL RESISTIVITIES OF DILUTE Mg–Nd AND Mg–Gd ALLOYS. J. Bijvoet, B. de Hon, J. A. Dekker, and G. W. Rathenau (Universiteit, Amsterdam). Solid State Commun., 1: 237-40(Dec. 1963).

The electrical resistivities of Mg–Nd and Mg–Gd alloys with a rare earth content of less than 0.25 at. % were measured. No resistance anomaly was found down to 1°K. Between 293 and 77°K Matthiessen's rule is obeyed. The values of the resistivities fit in with those of other Mg alloys. They differ from earlier measurements. (auth)

**7246** THE CRYSTAL STRUCTURES OF BERYLLIUM-RICH COMPOUNDS IN THE SYSTEMS Mo–Be AND W–Be. P. I. Kripyakevich and E. I. Gladyshevskii (Lvov State Univ.). Soviet Phys.-Cryst. (English Transl.), 8: 349-51 (Nov.-Dec. 1963).

Studies were made on the crystal structures of $MoBe_{22}$ and $WBe_{22}$ in the systems Mo–Be and W–Be, respectively. The lattice periods of $MoBe_{22}$ and $WBe_{22}$ were determined by the precision method to be 11.634 ± 0.002 and 11.631 ± 0.002 Å, respectively. Both compounds occupy a special position among the intermetallic compounds of beryllium, not only as regards their composition but also as regards their structure. The coordination number of the R atoms in a number of compounds of R and Be increases as the R content decreases. The coordination number of the R atom (and also the packing density of the atoms) is lower in the structure of $RBe_{22}$ than in the structures of $RBe_{12}$ and $RBe_{13}$. (P.C.H.)

**7247** YTTRIUM BERYLLIDE AND COMPOUNDS OF THE TYPE $ABe_{13}$. N. N. Matyushenko and G. F. Tikhinskii (Physicotechnical Inst., Academy of Sciences, Ukrainian SSR). Soviet Phys.-Cryst. (English Transl.), 8: 351-3 (Nov.-Dec. 1963).

Studies were made on the Be–Y system in order to establish the existence of intermetallides in it and to systematize the compounds of type $ABe_{13}$ according to their formula volumes. The existence of a cubic phase $YBe_{13}$, isomorphous with $NaZn_{13}$ and with a lattice period a = 10.238 ± 0.002 A, was established. It was concluded that the known $ABe_{13}$ beryllides can be divided into three groups according to their volume relationships to the volume of the A component: Sc, Hf, Zr; Mg, Er, Y, Ca, Am; Np, U, Pu, Th, Ce, La. (P.C.H.)

**7248** THE STRUCTURES OF COMPOUNDS OF COMPOSITION AB OF RARE EARTH METALS WITH ANTIMONY AND BISMUTH. R. N. Kuz'min and S. V. Nikitina (Moscow State Univ.). Soviet Phys.-Cryst. (English Transl.), 8: 354-5(Nov.-Dec. 1963).

Studies were made on the structures of Bi and Sb compounds with La, Ce, Pr, Nd, Tb, Dy, Ho, and Er, of composition AB. Measurement, calculation, and indexing of the x-ray patterns of the compounds indicated that they all crystallize in the cubic system; the space group is $O_h^5$. Their inclusion in the NaCl structure type was confirmed by comparison of calculated and measured intensities. The unit cell periods of the compounds are tabulated. (P.C.H.)

**7249** A STUDY OF THE SOLUBILITY OF ZIRCONIUM IN CHROMIUM. R. F. Domagala (Illinois Inst. of Tech., Chicago). Trans. Am. Soc. Metals, 56: 878-80(Dec. 1963).

Studies on the solubility of Zr in Cr indicated that the maximum solid solubility of Zr in Cr is less than 1 wt % (<0.6 at. %). The existence of a $Cr_{ss}$–$ZrCr_2$ eutectic was confirmed; the temperature of the eutectic reaction is 1525 ± 25°C. (P.C.H.)

**7250** USE OF THE RARE AND RARE-EARTH METALS AND THEIR COMPOUNDS IN SILICATE TECHNOLOGY. A. I. Avgustinik. Zh. Vses. Khim. Obshchestva im. D. I. Mendeleeva, 8: 135-41(1963).

A survey was made on the chemical, physical, and technological properties of the elements, metals, and compounds considered to have considerable future prospects for utilization in silicate technology. Sections are devoted to the properties of the following elements and their compounds: lithium, beryllium, strontium, zirconium, hafnium, thorium, tantalum, niobium, and the rare-earth elements. Data are tabulated for specific gravity, melting point, coefficient of expansion, heat conduction, specific electric resistance, microhardness, and modulus of elasticity for the relatively new refractory zirconium compounds, ZrC, ZrN, $ZrB_2$, and $ZrSi_2$; the specific gravity, crystal lattice system, lattice constant, melting point, boiling point, coefficient of linear expansion, and neutron absorption for tantalum and niobium; and the melting point, boiling point, specific gravity, coefficient of linear expansion, magnetic susceptibility, thermal neutron capture cross section, oxide obtained from ignition in air, and melting point of the oxide for the rare earth metals. 111 references are included. (OTS)

**7251** MODERN CONCEPTS OF THERMAL STABILITY OF REFRACTORY CERAMIC MATERIALS AND MEANS OF INCREASING IT. G. V. Kukolev and I. I. Nemets. Zh. Vses. Khim. Obshchestva im. D. I. Mendeleeva, 8: 155-62 (1963).

A review is presented on the modern state of research on the thermal stability of refractory ceramic materials and efforts to improve this property, designed to make them suitable for use under conditions of high or alternating temperatures, such as in atomic reactors, rockets, and jet

engines. A detailed theoretical analysis of the mechanism and conditions of the phenomenon of thermal shock in brittle materials is included. Methods for determining the value of the thermal stability are categorized and analyzed, and the need for further development is pointed out. Studies aimed at improving the thermal stability of refractory ceramics are briefly cited, and their general principles discussed. 140 references are included. (TCO)

**7252** NEUTRON DIFFRACTION INVESTIGATION OF A GADOLINIUM SINGLE CRYSTAL. G. Will, R. Nathans, and H. A. Alperin. 7p. (CONF-342-2: BNL-7504)

From Conference on Magnetism and Materials, Atlantic City, Nov. 1963.

Neutron diffraction studies were made on a single gadolinium crystal in an attempt to find direct evidence for the existence or non-existence of any sinusoidal variation in the magnitudes of any component of the magnetic moment. The absence of observable satellite reflections indicates that Gd behaves as a normal ferromagnet. Above 248°K the magnetic moment is directed along the c-axis while below this temperature the direction varies continuously and exhibits a maximum at 195°K. It was concluded that Gd is not expected to show a helical antiferromagnetic structure, even in zero field. (P.C.H.)

**7253** DIFFUSION AND THERMAL DEFECTS IN SOLIDS. A. D. Le Claire (Atomic Energy Research Establishment, Harwell, Berks, Eng.). 47p. (CONF-135-6)

From International Symposium on High Temperature Technology, Asilomar, Calif., Sept. 1963.

A review is presented on the more important methods by which rates of diffusion in solids have been found to be most reliably and informatively determined. Some of the more useful methods that have been used to identify the fundamental mechanisms of atomic mobility and to determine the properties and types of defect structure responsible for it are described. 87 references are included. (P.C.H.)

**7254** THERMAL CONDUCTIVITY AND LORENZ FUNCTION OF GADOLINIUM BETWEEN 5 AND 310°K. Sigurds Arajs and R. V. Colvin (United States Steel Corp., Monroeville, Penna.). 8p. (CONF-342-4)

From Conference on Magnetism and Materials, Atlantic City, Nov. 1963.

The thermal conductivity ($\lambda$) of a polycrystalline gadolinium sample, having the electrical resistivity of 2.41 $\mu\Omega$ cm at 4.18°K, was studied as a function of temperature (T) between 5 and 310°K. The thermal conductivity has a maximum value of 0.333 W $cm^{-1}$ $°K^{-1}$ at 16.5°K. Changes in the slope of the $\lambda$ vs T curve occur at 230 and 270°K. The former is believed to be due to the rapidly varying easy cone of magnetization. The second anomaly is associated with the ferromagnetic-paramagnetic transformation. The Lorenz function, using the measured thermal conductivity and electrical resistivity data on the same sample, was calculated as a function of temperature. The function clearly indicates that in addition to the electronic thermal conductivity there is also considerable phonon and possibly some magnon heat transport. (auth)

**7255** THE ASSESSMENT OF STEELS FOR NUCLEAR REACTOR PRESSURE VESSELS. A. Cowan and R. W. Nichols (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.). New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-193, 13p, $1.00. (CONF-102-29)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

Some of the materials problems associated with the use of mild steels in large gas-cooled reactor pressure vessels are discussed. Tests to failure of 5-ft-dia 0.36-percent carbon–steel vessels with through-thickness longitudinal slots, supported by tests on 7-ft-wide centrally slotted flat plates, indicated that rapid failure at working-stress levels can only initiate from very long cracks, feet rather than inches in length. Of the mechanisms whereby realistic defects can grow to these sizes, brittle-crack propagation is considered the most important and this can be prevented by the maintenance of a minimum pressurization temperature, based on the crack-arrest temperature. The tests used to assess the crack-arrest temperature of plates up to 4 in. thick are described; compared with tests on thinner specimens the thick plate gives arrest temperatures higher by approximately 10 deg C per in. of test-specimen thickness. A comparison is made of crack-arrest temperature and data given by small-scale tests, particularly the Charpy V-notch test. Mechanical limitations of creep deformation in some current designs have been quite restrictive on design stress. The test data quoted for stress-rupture and fatigue indicate that these modes of crack extension quoted are not important in current designs. Possible magnitudes and effects of stress concentrations are quoted but there is little direct evidence of the effect of operating in the creep range on these stress concentrations. (auth)

**7256** NEW NUCLEAR MATERIALS INCLUDING NON-METALLIC FUELS. VOLUME I. Proceedings of the Conference Held by the International Atomic Energy Agency at Prague, 1-5 July 1963. (International Atomic Energy Agency, Vienna). Proceeding Series. November 1963. 574p. (STI/PUB/77(Vol.I))

Thirty-four articles are included; separate abstracts were prepared for 15. The 19 articles previously abstracted in NSA include information on non-metallic fuels, production of reactor fuel oxides, fabrication of $UO_2$ pellets, relation between lattice parameters and composition of non-stoichiometric $UO_2$, high temperature reaction in the $UO_2$–$TiO_2$ system, investigation of various processes in $UO_2$ dispersed in a matrix, direct measurement of the thermal conductivity of uranium oxide in-pile up to 1200°C, sintering of $UO_2$, problems of UC and UN technology, impregnation of graphite with liquid silicon in a vacuum, formation of $UC_{1-x}O_x$ and $UC_{1-x}N_x$, and synthesis of UC and $UC_2$ directly from uranouranic oxide. (P.C.H.)

*For abstracts of individual papers see: 7181, 7182, 7183, 7184, 7185, 7186, 7187, 7188, 7189, 7190, 7191, 7257, 7258, 7259, and 7260.*

**7257** THERMAL SHOCK TESTS ON $UO_2$ SMALL SPHERES. G. Perona, E. Brutto, U. Galbusera, G. Palladino, and R. Sesini (Centro Informazioni Studi Esperienze, Milan). p.251-68 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. I." Vienna, International Atomic Energy Agency, 1963.

A thermal shock method for the small $UO_2$ spheres was studied, and conditions are indicated in which the method can reproduce stress conditions directly comparable with those existing in the reactor. As for small spheres, the difficulty consists in producing coolings with very high values of the coefficient of surface heat transfer. The experimental methods are described and the results obtained are indicated. Application of the method seems to be very interesting particularly in the field of the technological research for improving the characteristics of the $UO_2$ small spheres by means of additives. In fact it allows the control of the total interesting effect with a single measurement. (P.C.H.)

**7258** THE TRANSMISSION OF INFRA-RED RADIATION THROUGH SINTERED URANIUM DIOXIDE. H. P. Myers and J.-A. Gyllander (Aktiebolaget Atomenergi, Studsvik, Sweden). p.323-9 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. I." Vienna, International Atomic Energy Agency, 1963.

The infra-red absorption spectra of samples of sintered uranium dioxide were measured in the spectral range 0.86 to 15μm. Together with previous data for shorter wave lengths the results were used to calculate the contribution that transmitted radiant energy may make to the heat transfer properties of $UO_2$. It is expected that in unirradiated $UO_2$, radiant energy transfer can only be significant above about 1500°K, at which temperature the contribution is ~10% of the lattice conductivity; at 3000°K it equals the lattice conductivity. It is argued that this probably represents the maximum contribution, since reflection losses, effects of temperature on the absorption spectrum and above impurities such as fission products will reduce the transmittance of irradiated $UO_2$. (auth)

**7259** THE STRUCTURE AND PROPERTIES OF U–C AND (UPu)–C ALLOYS. L. E. Russell (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.409-28 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. I." Vienna, International Atomic Energy Agency, 1963.

Studies of the U–Pu–C system between 50 and 60 wt % C were carried out over the temperature range 1500–2100°C using ceramographic and x-ray techniques. The existence of complete solid solubility between $U_2C_3$ and $Pu_2C_3$ was established. It is shown that the decomposition temperature for $M_2C_3 \rightarrow MC + MC_2$ increases with the increase of Pu content over the range 0–30 mole % $Pu_2C_3$. The equilibrium phases present below 1700°C are $MC + M_2C_3$ but considerable segregation of Pu and U was observed in melted and quenched alloys. The solubility of oxygen in the monocarbides to form $MC_{1-x}O_x$ phases was studied by heat treating $U + C + UO_2$ in vacuo and by heat treating oxidized MC powders in flowing high-purity argon atmospheres. The maximum solubility corresponds to $0.25 < X < 0.35$ and this solution, which appears to be unaffected by variations in temperature between 1100 and 1600°C, is accompanied by a decrease in lattice parameter to 4.949 Å. The amount of oxygen that can be dissolved by heat treatment in argon is small and of the order of 0.2–0.3 wt %. Solution of the first small amounts of oxygen in hypostoichiometric M-C accompanied by an increase in lattice parameter. The stability of MC phases heated in nitrogen depends on the partial pressure of nitrogen in the heat treatment atmospheres. No increase in nitrogen content occurs in alloys heated at 1500°C in argon containing <5 ppm $N_2$ but when the $N_2$ concentration is >0.05 atm there is complete conversion to mononitride with the precipitation of free carbon. Variations in the thermal conductivity and thermal expansion of U–C and $(U_{0.85}\ Pu_{0.15})$–C alloys at 70°C were studied as a function of the carbon and oxygen contents and the method of manufacture. The thermal expansion of these monocarbides is not significantly affected by variations in the content of PuC, at 0 and 15 mole %, or by variations in the C or oxygen content or the method of fabrication. The thermal conductivity of the Pu-containing alloys is lower than that of the corresponding U–C alloys and the maximum conductivity in both cases is found in alloys containing close to the stoichiometric amount of carbon. (auth)

**7260** FURTHER STUDIES ON URANIUM CARBIDE AT THE JEN. H. Bergua and A. Fornes (Junta de Energía Nuclear, Madrid). p.477-506 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. I." Vienna, International Atomic Energy Agency, 1963. (In Spanish)

Uranium carbide is produced either from uranium metal for small quantities, a few kilograms per day, or from $UO_2$ for ton quantities. In the metallic uranium process, uranium turnings are first reduced to finely divided powder by hydriding and decomposing in vacuum the $UH_3$. The powder is then mixed with graphite powder, pressed into pellets, and either sintered or fed directly to the arc melting furnace. One melting is enough to give a uniform UC slug. Reduction of $UO_2$ with carbon is the process followed for bulk production of UC as feed material for the arc melting furnaces. The main problem is the reproducibility of the carbon content. The influence of the characteristics of the $UO_2$ powders, mixing, pressing, and the sintering cycle are discussed. UC bodies are prepared by arc melting and casting UC feed stock. Equipment used for this process is described. Some of the problems related with the method are discussed. A reference is also made to the problems involved in the handling and storage of UC and its relation with the gas content in the case of sintered UC. (auth)

**7261** HARD MATERIALS. Richard Kieffer and Friedrich Benesovsky. Vienna, Springer-Verlag, 1963. 602p. $28.50.

The manufacture, testing, properties, and technological applications of hard materials, such as sintered metal ceramics including carbide, nitride, boride, and silicide systems and nonmetal phases, such as diamond, nonmetal carbides, and oxides are discussed. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7262** CARBIDES. p.44-266 of "Hard Materials." Vienna, Springer-Verlag, 1963. (In German)

The production of carbides by melting, carburizing of metal or oxide powders, precipitation from the gas phase, electrolysis, sintering, properties, and technical usefulness of the following carbide systems: Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, Th, U, Pu, and Np carbides are discussed. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7263** HIGH TEMPERATURE MATERIALS. PART 2. VOLUME 18. G. M. Ault, W. F. Barclay, and H. P. Munger, eds. New York, Interscience Publishers, 1963. 848p.

A survey was made of fabrication processes, melting, casting, extrusion, forging, rolling, welding, and heat treatments of refractory metals and their alloys, oxides, nitrides, borides, and silicides. Application of the material for rockets, missiles, and aircrafts is also discussed. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7264** REVIEW OF THE STATUS AND FUTURE OF MOLYBDENUM AND COLUMBIUM ALLOYS. L. P. Jahnke. p.283-306 of "High Temperature Materials. Pt. 2. Vol. 18." New York, Interscience Publishers, 1963.

A survey was made of physical and mechanical properties of some Nb and Mo alloys and of the heat treatments and fabrication methods. The effects of interstitial carbon and oxygen, cold work, and various alloying elements on the rupture strength are also given. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7265** PROPERTIES OF SOME COLUMBIUM–RICH ALLOYS IN THE COLUMBIUM–TANTALUM–TUNGSTEN–ZIRCONIUM SYSTEM. W. O. Gentry and A. B. Michael. p.307-24 of "High Temperature Materials. Pt. 2. Vol. 18." New York, Interscience Publishers, 1963.

Data are reported for Nb rich alloys in the Nb–Ta–W–Zr system. The optimum strength, fabricability, ductility, weldability, and oxidation resistance were determined for

alloy of 27% Ta, 12% W, 0.60% Zr with the balance containing Nb. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7266** THE DEVELOPMENT OF HIGH-STRENGTH COLUMBIUM-BASE ALLOYS FOR REACTOR CLADDING APPLICATIONS. J. A. De Mastry, F. R. Shober, and R. F. Dickerson. p.335-46 of "High Temperature Materials. Pt. 2. Vol. 18." New York, Interscience Publishers, 1963.

Alloys containing Nb-2.3Cr-3.34Zr-5.21V and Cb-1.56-1.09 Cr were developed for reactor claddings. Data are given on hardness, ultimate tensile strength, and yield strength. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7267** VANADIUM-COLUMBIUM ALLOYS FOR 1800 TO 2200 F. SERVICE. B. R. Rajala and R. J. Van Thyne. p.371-83 of "High Temperature Materials. Pt. 2. Vol. 18." New York, Interscience Publishers, 1963.

A survey was made of the mechanical and physical properties and composition of various vanadium alloys containing Nb, Hf, Ti, and Zr. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7268** PRELIMINARY INVESTIGATION OF THE FABRICATION AND PROPERTIES OF HAFNIUM CARBIDE. W. A. Sanders, J. R. Creagh, C. Zalabak, and J. J. Gangler. p.469-83 of "High Temperature Materials. Pt. 2. Vol. 18." New York, Interscience Publishers, 1963.

Recent results of fabrication studies on Hf-C are presented, in addition to, room temperature evaluations of bend strength, elastic modulus and microhardness and elevated-temperature evaluations of bend strength thermal expansion, thermal conductivity, specific heat and electrical resistivity. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7269** PROCESSING AND PROPERTIES OF COLUMBIUM-BASE ALLOY Cb-74. C. R. McKinsey, A. L. Mincher, W. F. Sheely, and M. Schussler. p.703-15 of "High Temperature Materials. Pt. 2. Vol. 18." New York, Interscience Publishers, 1963.

The processing, oxidation resistance, and mechanical properties of Nb-74 alloy are discussed. Tensile strength, rupture stress, oxidation resistance, and ductility were determined. The results indicate that Nb-74 exhibits a combination of fabricability, high temperature strength, and low-temperature ductility. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7270** A REVIEW OF HIGH TEMPERATURE COATINGS FOR REFRACTORY METALS. James J. Gangler. p.719-47 of "High Temperature Materials. Pt. 2. Vol. 18." New York, Interscience Publishers, 1963.

A survey was made of various coating techniques, including pack cementation, vapor deposition, vacuum condensation, electroplating, arc plasma, and flame spraying, used for protecting Mo, Nb, W, Ta, and their alloys. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7271** THE PROTECTIVE QUALITIES AND KINETICS OF FORMATION OF Cb-Zn COMPOUNDS FORMED ON COLUMBIUM FROM ZINC VAPOR. G. Sandoz and T. C. Lupton. p.761-72 of "High Temperature Materials. Pt. 2. Vol. 18." New York, Interscience Publishers, 1963.

A study was made on the reaction between Nb and Zn when vapor is deposited on Nb, and on the oxidation resistance of NbZn, $NbZn_{1.5}$, $NbZn_2$, and $NbZn_3$ compounds formed. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7272** PROTECTION OF COLUMBIUM ALLOYS FOR HIGH TEMPERATURE SERVICE. E. N. Bamberger, R. G. Frank, L. Luft, and E. D. Sayre. p.773-88 of "High Temperature Materials. Pt. 2. Vol. 18." New York, Interscience Publishers, 1963.

Various types of coatings applied to Nb alloys are reviewed in terms of their specific application. The development of diffusion coating, which involves the application of 10Cr-2Si-Al, to the substrate by diffusion heat treatment is described. Oxidation resistance and mechanical properties of the coatings are given. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7273** CERAMIC COATINGS FOR COLUMBIUM. W. B. Hall and J. W. Graham. p.789-99 of "High Temperature Materials. Pt. 2. Vol. 18." New York, Interscience Publishers, 1963.

Flame spraying of oxide material sealed with glass on Nb alloy substrate is described. Oxidation, heat and thermal shock resistance, and impact and flexure strength of the coatings were determined. (TCO)

**7274** HIGH TEMPERATURE PROTECTIVE COATINGS FOR COLUMBIUM ALLOYS. R. A. Jeffrys and J. D. Gadd. p.801-18 of "High Temperature Materials. Pt. 2. Vol. 18." New York, Interscience Publishers, 1963.

Application of the Cr-Ti-Si and Cr-Ti-Al systems for diffusion coating of D-41, D-31, and F-48 Nb alloys to protect them against oxidation resistance is discussed. Detailed investigation was made of the interrelationship of time, temperature, particle size, and composition on coatings thickness and diffusion depth. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7275** ALUMINIDE AND BERYLLIDE PROTECTIVE COATINGS FOR TANTALUM. D. D. Lawthers and L. Sama. p.819-32 of "High Temperature Materials. Pt. 2. Vol. 18." New York, Interscience Publishers, 1963.

Description is given of the development of Al and Be coatings for pure Ta and a commercial Ta-10W alloy. Major emphasis is on coatings applied by hot dripping in pure Al, in various Al alloy baths, and in Sn base baths containing Al. The resulting aluminide and beryllide coatings have good oxidation and heat resistance. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

**7276** NONSTOICHIOMETRY, ORDER, AND MICROPHASES IN $CeCd_{4.5}$ SOLID SOLUTIONS. Guy R. B. Elliott and Joe Fred Lemons. p.153-69 of "Nonstoichiometric Compounds, Advances in Chemistry. Series 39." Washington, D. C., American Chemical Society, 1963.

Both a very large number of phases (microphases) and a comparatively broad single phase were observed in the same composition region near $CeCd_{4.5}$ using vapor pressure measurement. The broad single phase range results from random defects dissolved in an ordered parent lattice. Further ordering by the defects create the different microphases. Free energy data for $CeCd_{4.5}$ structures and for two phase structures with $CeCd_6$ and $CeCd_3$ are reported. Sources of bonding energy for the ordering reactions are discussed. (Rev. Metal Lit., 20: No. 12, Dec. 1963)

## Radiation Effects

**7277** (AAEC/TM-139) IRRADIATION DAMAGE ASPECTS OF DISPERSION FUEL ELEMENTS FOR THE H.T.G.C. REACTOR. B. S. Hickman (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). June 1962. 12p.

The concept of a dispersion fuel element is discussed with particular reference to irradiation damage. The application of this concept to the A.A.E.C. H.T.G.C. reactor

system is outlined, and the limitations imposed by irradiation damage considerations are discussed. The maximum desirable heavy metal–beryllium ratio (i.e., U+Th : Be) for the various systems under consideration should be about 1 : 55 for the system $(U,Th)Be_{13}$ in Be, 1 : 13 for the system $(U,Th)O_2$ in Be, and 1 : 8 for the system $(U,Th)O_2$ in BeO. The disadvantages of keeping the uranium and thorium in separate particles are discussed and it is suggested that to minimize irradiation damage effects, the fuel particles should consist of solid solutions of the uranium and thorium compounds. (auth)

**7278** (AERE-R-3998) RADIATION-RESISTANT GLASSES. J. V. Best (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Nov. 1963. 25p.

Several stabilized optical glasses are described which were developed to withstand radiation doses of $10^7$ r of γ radiation. Radiation stability data are also given for various other transparent materials including plate glass, perspex, and polystyrene. With suitable glasses it should be possible to satisfy most of the requirements for stabilized optical instruments, while plastic lenses can also be used in a number of cases where these are cheaper than lenses made from special glasses. High-density glasses for direct-viewing windows may be stabilized, but they are rather colored. Where several thick blocks are used, only the inner blocks near the source of radiation need be stabilized in order to save unnecessary light absorption. (auth)

**7279** (ANL-6103) EXAMINATION OF IRRADIATED RaLa SOURCE FUEL ROD (PROTOTYPE NO. 2) FOR LOS ALAMOS SCIENTIFIC LABORATORY. Final Report on Metallurgy Program 6.1.21. S. H. Paine, W. F. Murphy, and F. L. Brown (Argonne National Lab., Ill.). Oct. 1963. Contract W-31-109-eng-38. 22p.

A LASL fuel-bearing assembly was irradiated in the Materials Testing Reactor and subsequently examined at ANL. The design was found to be adequate for containing specimens irradiated to high burnup levels if certain defects introduced by the fabrication procedure are corrected. (auth)

**7280** (BNL-7501) EFFECTS OF IRRADIATION ON THE OPTICAL ABSORPTION AND PHOTOCONDUCTIVITY OF RUTILE. P. D. Townsend, H. K. A. Kan (Picatinny Arsenal, Dover, N. J.); and Paul W. Levy (Brookhaven National Lab., Upton, N. Y.). [1961]. Contract AT-30-2-GEN-16. 23p. (CONF-159-2)

From Proceedings of the British Ceramic Society Meeting on Point Defects in Non-Metallic Solids, Leamington Spa, England, Oct. 1963.

Optical absorption and photoconductivity measurements were made on single crystals of pure synthetic rutile ($TiO_2$). Reactor irradiations at 70°C totaling $4.8 \times 10^{18}$ nvt fast and $1.69 \times 10^{19}$ nvt slow did not produce any discernible optical absorption bands; however, the transmission decreased 5% at all wavelengths. Reactor irradiation induced at least five photoconduction peaks in the wavelength range 4200 to 14,000 A. In addition the photopeak at 4065 A (3.05 ev) was enhanced and there were drastic changes in the dependence of photocurrent with light intensity. Gamma-ray irradiations as large as $10^9$ r do not change the conduction properties. The photocurrent is proportional to a power of the light intensity; the power range from 0.65 to 1.24 for the crystals described. The photocurrent vs voltage dependence is more complex. (auth)

**7281** (BNL-7502) EFFECTS OF GAMMA-RAY IRRADIATION ON THE MECHANICAL PROPERTIES OF NaCl SINGLE CRYSTALS. F. Agulló-Lopez and P. W. Levy (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 31p. (CONF-159-1)

From Proceedings of the British Ceramic Society Meeting on Point Defects in Non-Metallic Solids, Leamington Spa, England, Oct. 1963.

The plastic behavior of both unirradiated and gamma-ray irradiated NaCl single crystals was studied with a variety of techniques. These include the determination of stress-strain curves, and photoelastic, surface, topography, and F-center absorption band measurements. The different stages of deformation in unirradiated crystals are compared with the corresponding stages of irradiated ones. One effect is that irradiation greatly extends the easy glide region. Some insight into this behavior is obtained from the photoelastic and topography measurements. In unirradiated crystals, almost all glide occurs on one slip system and there is considerable pile up. In irradiated crystals, slip occurs on two perpendicular systems, the number of operating glide planes is, at least, doubled, and the pile up is very much reduced. Both the yield point and F-center concentration increase rapidly with dose up to approximately $10^7$ r and at a much slower rate for larger doses. Also investigated was the effect of crystal shape (or geometry) on the stress strain curves obtained from unirradiated crystals. The most interesting results are that the yield point decreases with increasing cross section and that the slope of the linear strain hardening region depends on the ratio of the crystals shortest dimension to its height. (auth)

**7282** (CONF-339-3) DEUTERON IRRADIATION EFFECTS IN Al–1.7 AT. PER CENT Cu. Hubert Herman (Argonne National Lab., Ill.). Oct. 8, 1963. Contract W-31-109-eng-38. 8p.

From the Metallurgical Society of A.I.M.E. Fall Meeting, Cleveland, Oct. 1963.

Guinier-Preston (G.P.) zones are the first low-temperature metastable decomposition products of quenched supersaturated solid solutions, and they may be redissolved by a short-time heating (reversion) and then reformed at a slower rate on cooling. The effects of deuteron irradiation on the formation of G.P. I zones after reversion in Al–1.7 at. % Cu alloy were investigated. The deuteron doses employed were $10^5$ d/cm$^2$ at 10.5 Mev, and the formation of zones was followed by electrical resistance measurements. Normal reaging without irradiation gave a resistance maximum at ~10 hr, while irradiation before reaging gave a maximum at 5 min and irradiation after reaging gave a maximum at 10 min. The results indicate that the zone-forming reaction is being affected by irradiation with deuterons and that a significant fraction of the zones are passing through sizes large enough to give a maximum in resistance. (D.L.C.)

**7283** (CONF-339-4) THE EFFECTS OF IRRADIATION ON THE FORMATION OF GUINIER-PRESTON ZONES. Herbert Herman (Argonne National Lab., Ill.). Oct. 11, 1963. Contract [W-31-109-eng-38]. 27p.

From the Metallurgical Society of A.I.M.E. Fall Meeting, Cleveland, Oct. 1963.

Guinier-Preston (G.P.) zones are formed in alloys by quenching-aging from the single-phase region to the two-phase region of the equilibrium diagram. On dissolving (reversion) the G.P. zones and then reaging, the zones are reformed but at lower rates. An investigation was conducted on the effects of deuteron-induced defects on zone formation in quenching-aging and reaging of Al–5.3 at. % Zn alloy. 10.5-Mev deuterons were used, and electrical resistivity and small-angle x-ray scattering were used to study the zones. The results indicate that where the

vacancy concentration is low, as in the case after reversion, irradiation accelerates the zone-forming reaction. In the case of quenching-aging, however, the vacancy concentration is comparable to that produced by irradiation, and no acceleration is observed. It is concluded that thermal vacancies are responsible for the normally observed rates of zone growth. (D.L.C.)

**7284** (DP-859) IRRADIATION OF TANDEM-EXTRUDED JOINTS BETWEEN ZIRCALOY AND STAINLESS STEEL. J. Walter Joseph, Jr. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Oct. 1963. Contract AT(07-2)-1. 16p.

Tandem-extruded tubular joints between Zircaloy and stainless steel experienced no measurable loss of strength or serious bond deterioration during irradiation to neutron exposures greater than the exposures predicted for 20 years of service in a power reactor. As-extruded and cold-worked joints were subjected to axial tensile stresses during exposure to as many as $7.8 \times 10^{20}$ fast neutrons per square centimeter at a temperature of about 50°C. (auth)

**7285** (EURAEC-879) FISSION GAS RELEASE FROM URANIUM DIOXIDE. Quarterly Progress Report No. 11, July–September 1963. (FIAT. Sezione Energia Nucleare, Turin). Work Performed under United States–Euratom Joint Research and Development Program. Contract 021-60-9 RDI. 13p. (FN-E-37)

Ten experiments were performed on fission-gas release from uranium dioxide. Burnups varied from 69.6 to 669.5 Mwd/t and release rate parameters varied from $1.3 \times 10^{-15}$ to $3.3 \times 10^{-10}$. A decrease of the apparent diffusion coefficient, D′, with increasing irradiation dose was found for all the three kinds of pellets in the range 10 to 80 Mwd/t. Increasing with burnup, a recovery of this decrease was observed, which for some specimens apparently brought the D′ at approximately 200 Mwd/t up to values not far from those measured at 10 to 20 Mwd/t. The recovery appeared to be less prompt for other specimens, which had displayed the most remarkable decrease of D′ with burnup. Cooling bursts were observed following cooling from relatively high temperatures, 1730 and 1565°C. However, the occurrence of these bursts was rather erratic and it was not possible to correlate it with the specimen's characteristics. In a recent series of experiments it was observed that cooling bursts occur also with annealing temperatures of 1330 and 1400°C, provided the cooling rate of the $UO_2$ is sufficiently high. (auth)

**7286** (FGT-1880) MATERIALS—SOLID FILM LUBRICANTS—IRRADIATION AT FOUR FLUXES AND ONE TEMPERATURE—EFFECTS OF. [Period Covered], November 25, 1957–February 7, 1958. J. H. McKenna (Convair, Fort Worth, Tex.). Feb. 28, 1958. Contract AT33(600)-32054. 14p. (AD-279322)

In order to determine the effects of nuclear radiation on Electrofilm #4396 solid film lubricant, test specimens, as received from the vendor, were exposed to four flux levels at ambient temperature in Materials Component Irradiation #6. Results of the tests showed a marked increase in wear-life of irradiated specimens. Significantly, this increase followed a positive slope from Flux I (lowest level) to Flux III, and then a negative slope to Flux IV (highest level). Concurring with nuclear studies over the past few years, the test data indicated that irradiation was responsible for polymerization of the resin binder in the lubricant film, promoting crosslinking of the polymer bond and thereby causing better film adhesion. At Flux III, this phenomenon theoretically reached the maximum permissible radiation level for this polymer. At Flux IV, excessive crosslinking probably caused embrittlement of the polymer, resulting in somewhat decreased adhesion and wear-life characteristics of the lubricant. (auth)

**7287** (GA-4797) RADIATION EFFECTS ON SILICON SOLAR CELLS. Technical Summary Report, May 16, 1963 through October 15, 1963. V. A. J. van Lint, J. W. Harrity, D. K. Nichols, and D. P. Snowden (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Dec. 4, 1963. Contract NAS7-91. 52p.

The following studies were carried out: 1) Studies of excess carrier recombination and lifetime in n-type silicon both before and after irradiation. 2) ESR studies of A centers and other dominant resonance lines in electron-irradiated silicon. 3) Analysis of mobility data on irradiated silicon to determine the introduction rate of ionized impurity centers. 4) Studies of statistics of electron-hole recombination for a two-level system. (D.L.C.)

**7288** (GEAP-4088) STUDIES OF $UO_2$–CLADDING MECHANICAL INTERACTIONS. (SHORT TIME IRRADIATIONS IN THE GETR TRAIL CABLE FACILITY). V. E. Hazel, M. F. Lyons, and F. A. Comprelli (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 1962. Contract AT(04-3)-189. 42p.

This report is a supplement to GEAP-3739, Plastic Strain in Thin Fuel Element Cladding Due to $UO_2$ Thermal Expansion, by M. F. Lyons, et al. Cladding growth results are reported for repetitively irradiated $UO_2$ pellet-filled annular capsules, for two $UO_2$ powder-filled annular capsules, and for six solid cylindrical pellet-filled capsules. Dimensional changes of the capsules irradiated during the entire program were analyzed, and the relationship of these results to the over-all fuel development program was evaluated. (auth)

**7289** (GEMP-30A) HIGH-TEMPERATURE MATERIALS PROGRAM. PROGRESS REPORT NO. 30, PART A. (General Electric Co. Advanced Technology Services, Cincinnati). Dec. 31, 1963. Contract AT(40-1)-2847. 36p.

Volume expansion in BeO specimens irradiated at 600 and 800°C to a dosage of about $10^{21}$ nvt (≥1 Mev) ranged up to approximately 3.6%. In general, the expansion was greater in the larger grain sizes and at the lower irradiation temperature. Strength measurements indicated that most of the specimens had undergone some degree of grain-boundary separation. As in previous tests, specimens of the small grain sizes (<10 microns) experienced the least reduction in strength; this higher strength appeared to result from smaller expansion rather than greater stability to grain-boundary separation. Measurements of the porosity and strength of specimens of 5-micron grain size irradiated at 100°C indicated that grain-boundary separation occurs at 2 to $2.5 \times 10^{20}$ nvt (≥1 Mev). This result, which disagrees with lattice parameter data on the dosage corresponding to grain-boundary separation, indicated that the strength and porosity measurements are more sensitive measures of microcracking. Helium retention measurements indicated that up to 40% of the helium formed escapes from specimens in irradiations up to about $10^{21}$ nvt (≥1 Mev). Helium escape is significantly influenced by grain-boundary separation and specimen porosity. An ion source was fabricated, and magnetic field strengths of the source were measured as a function of current flow. A vacuum system capable of $3 \times 10^{-7}$ Torr and suitable for calibrating low-pressure sensors in different atmospheres was also assembled. The optimum operating conditions for a thermistor manometer were determined in the pressure range from $5 \times 10^{-4}$ to $9 \times 10^{-3}$ Torr. A high-temperature tungsten furnace was assembled and tested to a temperature of

2800°C. A glow discharge assembly was constructed, tested with a hot tantalum cathode, and found to fulfill the requirements for such a system. Initial research to establish the feasibility of thoria as an internal conversion fuel in BeO was started on the basic $UO_2-ThO_2-Y_2O_3$ system. It was found that specific compositions with $UO_2:ThO_2:Y_2O_3$ mole ratios of 1:1:0.55, and 1:2:0.55 could be reacted at 1650°C for 30 hours in air to develop single-phase face-centered cubic solid solutions. Preliminary fuel retention tests were made at 1400 and 1500°C in air on BeO specimens containing a dispersion of 10 and 20 wt % $UO_2$ as a binary or ternary solid solution with $ThO_2$ and $Y_2O_3$. These tests showed that fueled BeO specimens with $UO_2$-to-$ThO_2$ mole ratios ranging from 1:1 to 1:2 lost less than 1% $UO_2$ after 500 hours at 1400°C, and less than 5% after 300 hours at 1500°C. Within this same composition range, processing of the fuel additives by either co-precipitation as hydrous oxides or mechanical mixtures of oxides had little effect on the subsequent fuel loss from BeO specimens. (auth)

**7290** (HW-77954(p.3.1-20)) NEUTRON DAMAGE TO METALS. H. E. Kissinger, J. J. Laidler, B. Mastel, and G. E. Miller (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A variety of tests was performed on unirradiated and irradiated single crystals of molybdenum. Significant increases in lattice parameter and line widths occurred in irradiated crystals containing 450 ppm carbon. Carbon affects the mode of plastic deformation. Irradiation to $10^{18}$ nvt resulted in the development of a yield point and extended easy glide, and a decrease in strain hardening rate; postirradiation ageing resulted in an increase in resolved shear stress and a decrease in ductility. Similar effects were observed in crystals irradiated to $10^{19}$ nvt. Nonuniform tensile deformation was common. Polycrystalline molybdenum tensile specimens with an annealed and cold-worked microstructure were encapsulated for irradiation and damage recovery experiments. Defect structures introduced by irradiation and discernible by transmission microscopy were completely eliminated in high purity molybdenum (<20 ppm carbon) after postirradiation annealing at 900°C; small loops persisted in molybdenum containing 150 and 450 ppm carbon. X-ray line widths and lattice parameters regained their original preirradiation values as a result of the 900°C (1652°F) anneal. The crystallography of dislocation channeling in irradiated and subsequently strained molybdenum was derived. Preliminary attempts at introducing fission fragment damage in 1000 Å thick molybdenum foils were unsuccessful, and only the damage associated with the fast neutron bombardment was observed. Nickel foils (face-centered cubic) of differing purity and differing metallurgical states are being irradiated for subsequent x-ray and electron microscope study. Preparation of specimens of rhenium (hexagonal close packed) are in progress. (auth)

**7291** (HW-77954(p.3.21-54)) SWELLING OF IRRADIATED FISSIONABLE MATERIALS. R. D. Leggett, B. Mastel, and J. W. Weber (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The construction and bench testing of six controlled-temperature general-swelling capsules was completed and two of them were charged into a reactor. These capsules contain specimens of varying composition, metallurgical history, and enrichment. Three previously irradiated capsules were opened and the specimens partially processed. Three additional irradiated capsules are being stored in the reactor discharge basin awaiting shipment for specimen recovery and examination. Observations were made on high purity uranium specimens irradiated as 525°C (977°F), 0.03 at. % burnup; 575°C (1067°F), 0.10 and 0.15 at. % burnup; and 625°C (1157°F), 0.10 at. % burnup. Also examined were specimens enriched to 1.44 at. % $U^{235}$ that were irradiated to 0.15 at. % burnup at 575°C (1067°F). The observations correlated well with previous data obtained from this series of irradiations. A tentative theory was advanced to explain the behavior of high purity uranium specimens irradiated in the 400 (752°F) to 625°C (1157°F) range up to 0.4 at. % burnup. The proposal suggests that fission-event-induced damage and the recovery thereof is almost entirely responsible for the observed volume changes in the intermediate temperature range. The fission gases only become important above about 600°C (1112°F). The dependence of volume change on irradiation temperature is thought to go through a maximum at about 500°C (932°F). Twenty-six NaK-filled capsules containing Zircaloy-2 clad rods of uranium and uranium–2 wt % zirconium were discharged and the samples from two of the capsules recovered. As with previous irradiations the uranium–2 wt % zirconium exhibited larger volume increases than did unalloyed samples. The magnitude of the volume changes of these clad rods was much smaller than was the case for bare high-purity uranium specimens. This is thought due to the beneficial effects of the cladding and the higher impurity level. Two thorium specimens irradiated to 0.18 and 0.92 at. % burnup, respectively, exhibited no change in microstructure or density after a 750°C (1382°F) anneal for 100 hours but did show an appreciable decrease in microhardness. Four thorium-uranium (1.0, 4.0, and 5.4 wt %) tensile specimens irradiated from 0.6 to 1.5 at. % burnup were tested to fracture. It was observed that the total elongation decreased as the total exposure (nvt) increased. The atomic percent burnup did not correlate with any of the mechanical measurements. (auth)

**7292** (HW-77954(p.4.1-12)) ALLOY SELECTION. T. T. Claudson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Charpy impact specimens of AISI 406 stainless steel and Hastelloy X-280 and tensile specimens of R-27, R-41, R-235, Inconel 718, Inconel 625, and TD Nickel are being irradiated at 525°C (975°F) in a gaseous environment. Similar specimens of Incoloy 800, Inconel 600, and Inconel X-750 are being fabricated for a similar irradiation. Characterization of W–25 wt % Re, Ta–10 wt % W, TZM, Nb–1 wt % Zr, and Nb–752 refractory alloy materials is being conducted. Fabrication histories and mechanical properties of these alloys are given. Tensile specimens prepared for irradiation in the ETR at ambient water temperature are also described. Tensile specimens of R-27, R-235, Hastelloy N, Inconel 625, Inconel 718, and TD Nickel were irradiated and discharged from the ETR G-7 hot-water loop facility. These specimens are being tested and the data evaluated. All specimens were irradiated at a temperature of 280°C (536°F) to exposure levels of $5.88 \times 10^{19}$, $1.2 \times 10^{20}$, and $5 \times 10^{20}$ nvt. (auth)

**7293** (HW-77954(p.4.13-18)) IN-REACTOR MEASUREMENTS OF MECHANICAL PROPERTIES. J. J. Holmes, D. H. Nyman, and J. A. Williams (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A recently completed creep test of 20% cold-worked Zircaloy-2 stressed at 20,000 psi and at a temperature of 350°C (662°F) showed an average creep rate of $1 \times 10^{-6}$/hour, in qualitative agreement with previous results. An analysis of activation energies for steady state creep of 20% cold-worked Zircaloy in a neutron flux showed the

results fall in two families of straight lines. One family has an activation energy of 86 kcal/mole and is believed to represent creep over radiation-produced barriers whose concentration is determined by the dynamic equilibrium between their rate of production and rate of annealing. The other family has an activation energy of 58.5 kcal/mole and represents the energy for self-diffusion. The transition temperature varies with stress but is approximately 385 to 420°C (724 to 788°F). (auth)

**7294** (HW-77954(p.4.19-77)) IRRADIATION EFFECTS. A. L. Bement, J. E. Irvin, R. G. Hoagland, and K. R. Wheeler (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Studies of the change in mechanical properties of structural materials with irradiation were continued with the discharge of specimens of AISI 406 stainless steel, Zircaloy-2, and nickel-base alloys irradiated from $5.9 \times 10^{19}$ to $7.2 \times 10^{21}$ nvt in the ETR G-7 hot-water loop. In order to determine the role that irradiation temperature plays on radiation damage, stainless steel and nickel-base alloys are also being irradiated at ambient water temperature in the ETR. Flux dosimetry data obtained from the G-7 core position over seven cycles of irradiation are summarized; and flux values obtained from iron, nickel, and titanium flux wires are compared. Flux values based on iron and nickel are in close agreement (within 2%), whereas values based on titanium are higher by 7.5% at a peak flux of $10^{14}$ nv. Changes in mechanical properties of AISI 304, 348, 410, and AM-350 stainless steels with neutron flux are presented. Property changes after irradiations both below 200 and 540°F (282°C) are compared. In general, changes in yield strength with neutron exposure occurred at a faster rate at 540°F (282°C) than at ambient temperatures, when the changes were based on as-prepared properties. Out-of-reactor loop exposures for comparable periods of time caused significant changes in properties due to thermal effects alone. When thermal effects were accounted for, damage accumulation at 540°F (282°C) was in better agreement with that observed at ambient temperatures (160°F, 71°C). Strain rate and notch acuity effects on the ductile-to-brittle fracture transition temperature for Zircaloy-2 are described. A decrease in testing rate from impact velocities to 0.05 in./min crosshead speed reduced the transition temperature from 300 to 350°C (570 to 600°F) to approximately −175°C (−280°F). Crack initiation in the presence of a dull notch consumed considerable energy, giving a $G_c$ value of 280 in./lb/m$^2$ at −196°C (−321°F). At subtransition temperatures specimens tested at a faster rate exhibited a greater bending strength, indicating that plastic deformation in the working zone of the crack controls propagation. A development to explain the shift in the point of maximum load from the start of necking in a tensile test is presented. This shift is attributed to nonuniform deformation which occurs in various degrees in all polycrystalline metals but is most prevalent in metals which undergo substantial deformation twinning. (auth)

**7295** (HW-77954(p.5.30)) IRRADIATION OF TITANIUM. R. S. Hope (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Activity and decay rates were obtained for two samples of titanium irradiated for 70 hr. (M.C.G.)

**7296** (HW-77954(p.6.1-2)) INCONEL PRESSURE TUBE FROM DR-1 GAS LOOP. L. J. Defferding (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Observed heavy precipitate at the grain boundaries in the low temperature end of an Inconel pressure tube from the DR-1 in-reactor gas loop was attributed to temperatures attained during heat treatment or during fabrication of the loop. The sulfur contamination reported previously was found to be localized near the transverse break in the tube, while a 3 to 5 mil corrosion layer was found to be present throughout the entire in-reactor portion of the tube. (auth)

**7297** (HW-77954(p.6.3-4)) EFFECT OF TEMPERATURE ON BURST STRENGTH OF ZIRCALOY-2 PRESSURE TUBES. M. C. Fraser (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Burst tests were performed at several temperatures in the range from room temperature to 600°F (316°C) to obtain data on the influence of test temperature upon bursting strength of irradiated Zircaloy-2 PRTR pressure tubes. The data indicated that for fast neutron exposure in the range $5 \times 10^{18}$ nvt to $4 \times 10^{20}$ nvt bursting strength decreased by 10%/100°F increase. (auth)

**7298** (HW-78962(p.3.1-14)) NEUTRON DAMAGE TO METALS. H. E. Kissinger, J. J. Laidler, B. Mastel, and G. E. Miller (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Large loops present in neutron-bombarded molybdenum containing carbon grow in size during annealing at 750°C (1382°F); they are eliminated by moving dislocations, and channels free of defects are formed. As perceived by transmission electron microscopy, the large loops behave in a manner analogous to the spot defects present in as-irradiated foils, and possibly arise from the same type of defect, namely vacancies. Transverse foil sections from single-crystal molybdenum were successfully prepared and thinned for electron microscopy. Thinning techniques for rhenium and nickel with several levels of impurities were refined. X-ray diffraction micrography revealed the degree of perfection of single crystals of molybdenum prepared by the floating-zone technique; the effect of thermal treatments on substructure is currently being investigated. The influence of strain-rate and temperature on the yielding and flow of polycrystalline molybdenum is being studied. For strain rates greater than $5 \times 10^{-5}$ sec$^{-1}$ at 295°K, the strain rate sensitivity of annealed polycrystalline molybdenum is approximately four times that of cold-worked specimens; at lower strain rates there is no strain rate effect. Strain-rate-change experiments performed on annealed polycrystalline molybdenum indicated a parabolic dependence of the increase in flow stress (resulting from a 10-fold increase in strain rate) upon strain. Six tungsten field ion emitters with <100> and <110> orientations were photographed to establish the preirradiation microstructural state; the emitters are scheduled for irradiation in the near future. (auth)

**7299** (HW-78962(p.3.15-34)) SWELLING OF IRRADIATED FISSIONABLE MATERIALS. R. D. Leggett, B. Mastel, Y. E. Smith, D. J. Bailey, and J. W. Weber (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Controlled-temperature irradiations of uranium specimens proceeded on schedule; two capsules were charged to replace two that were discharged. Assembly of two capsules containing specimens having different shapes was completed. Design of a pressurized capsule that will permit study of the effect of restraint was continued. Postirradiation metallography on fine grained specimens irradiated at 640 and 625°C (1184 and 1157°F) revealed grain boundary porosity, and this was greater in the specimen irradiated at the lower temperature. Observations agreed

well with data and conclusions previously obtained. A specimen beta-heat-treated prior to irradiation at 525°C (977°F) to $0.15 \times 10^{20}$ fissions/cc (0.03 at. % burnup) showed crystallographic alignment of tears and two different types of twins. Two specimens irradiated at controlled temperatures were annealed after irradiation and are being processed. A series of clad and declad specimens irradiated at low temperature [~ 300°C(~ 572°F)] were pulse annealed and are also being processed. Second phase delineation for particle size and distribution analysis was continued on a series of dingot and ingot base alloys containing Fe, Si, and Al. Specimen preparation and etching conditions differ considerably for the different alloys. (auth)

**7300** (HW-78962(p.4.1-44)) ALLOY SELECTION. T. T. Claudson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

All fabrication histories, heat treating schedules, and chemical analyses presently available for A-212B, AISI 302B, AISI 304, AISI 348, AM-355, AM-350, Inconel 600, and Inconel X-750 materials procured for use in the coordinated program on irradiation effects on structural materials are published. A number of solution and precipitation hardenable alloy specimens and some refractory metal alloys were received after irradiation in the ETR G-7 facility and are presently being tested. (auth)

**7301** (HW-78962(p.4.45-9)) IN-REACTOR MEASUREMENTS OF MECHANICAL PROPERTIES. J. J. Holmes, D. H. Nyman, and J. A. Williams (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

In-reactor creep tests of 20% cold-worked Zircaloy-2 were initiated for test conditions of 35 ksi stress at 320°C (608°F) and 25 ksi stress at 365°C (688°F) and completed for test conditions of 25 ksi stress at 350°C (662°F) and 35 ksi at 310°C (590°F). The available results of these tests are presented. Data from all steady state creep tests performed to date are presented in the form of an Arrhenius plot. At lower temperatures the creep rate is controlled by radiation-produced obstacles to creep and has an activation energy of 86 kcal/mole; as the temperature is increased, these defects anneal out and the defect concentration decreases to the equilibrium value for this temperature while the activation energy drops to 60 kcal/mole. The transition temperature is stress dependent. The capsule development program for a 1300°C (2372°F) capsule is described. (auth)

**7302** (HW-78962(p.4.50-126)) IRRADIATION EFFECTS. A. L. Bement, J. E. Irvin, R. G. Hoagland, K. R. Wheeler, and J. W. Carter (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

An operating history of the G-7 hot water loop in the ETR is presented. A modification in the cross section values for neutron reactions resulted in a 5% decrease in calculated flux and brought the results from Fe, Ti, and Ni monitors into closer agreement. A continuous scanning technique is being evaluated that will provide continuous monitoring of flux over the length of the core rather than the present point monitoring system. Comparison of the yield strengths of Zircaloy-2 irradiated at two temperatures with several models for damage accumulation showed the best agreement is obtained using a power law flux dependence with saturation. With this treatment, the data fall into three groups each characterized by different levels of flux and irradiation temperature. Notched tensile results for 0, 10, 20, and 40% cold-worked Zircaloy-2 are presented. A pronounced difference in notch strength between specimens in the as-prepared condition and after exposure in the out-of-reactor loop was tentatively attributed to an oxide coating. Irradiated specimens of 0, 10, and 20% cold work showed strength changes to $4 \times 10^{19}$ nvt and little change thereafter. The 40% samples become notch sensitive above $9 \times 10^{19}$ nvt. The tensile properties of irradiated AISI 304, AISI 348, AISI 410, and AM-350 obtained to date are presented. Notable features include the anisotropy observed in mechanical properties and accentuation of damage observed in AISI 348 irradiated at 280°C (540°F). Magnetic measurements to determine the martensitic content of stainless steels are described. Results of notch tensile tests of AISI 348 are reported for 0, 10, 20, and 40% cold work. The notch strength was found to be sensitive to loading rate. Observations of the fracture behavior of Zircaloy-2 in notched bend tests are discussed and correlated with electron micrograph observations of the fracture surface. A review of the thermodynamic treatment of fracture and an analysis of the effect of rate sensitivity on fracture behavior of metals are given. (auth)

**7303** (HW-78962(p.4.127-30)) RADIATION-DAMAGE EXPOSURE UNITS. R. E. Dahl and H. H. Yoshikawa (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

An exposure unit is proposed based on the number of neutrons/cm$^2$ having energies above a specified energy limit $E_L$ where $E_L$ is specified by the condition that the integrated flux above $E_L$ be proportional to the gross displacement production for the spectra under consideration. (auth)

**7304** (HW-78962(p.4.131-34)) DAMAGE MECHANISMS. F. A. Smidt and B. Mastel (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The addition of trace amounts of titanium to iron was found to remove all traces of the yield point and inhomogeneous yielding. The strain rate sensitivity of the lower yield point in "Ferrovac-E" was found to be linear over the range 0.002 min$^{-1}$ to 2.0 min$^{-1}$. Electron transmission microscopy observations on movement of dislocations in irradiated iron foils showed them to differ from movements observed in unirradiated foils, in that they were more erratic and localized pinning was frequently noted. (auth)

**7305** (HW-SA-3020) THE USE OF CHEMICAL ADDITIVES FOR IMPROVED GRAPHITE DENSIFICATION AND NEUTRON RADIATION STABILITY. W. E. Parker, R. W. Marek (Speer Carbon Co., Niagara Falls, N. Y.); and E. M. Woodruff (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [June 11, 1963]. Contract AT(45-1)-1350. 39p. (CONF-73-15)

From 6th Biennial Conference on Carbon, Pittsburgh, June 1963.

The use of small percentages of chemical additives in the fabrication of graphites was studied for effects on graphite physical properties and irradiation stability. Transition-metal compounds were the additives employed. Increased graphite densities and a higher electrical resistivity resulted from use of $Fe_2O_3$, $Ni_2O_3$, and $CrCl_3 \cdot 6H_2O$. Improved stability to radiation-induced dimensional changes appears to result from use of additives. (auth)

**7306** (NP-13463) GODIVA III— MINUTEMAN RADIATION EFFECTS TESTS. H. J. Lubatti and H. W. Wicklein (Boeing Airplane Co., Seattle). Oct. 1960. Contract AF04 (647)-289. 107p. (T2-2128)

Transient radiation effects tests on silicon controlled rectifiers (SCR), associated Minuteman circuits, and tantalum and aluminum electrolytic capacitors were performed at the Godiva III prompt critical assembly, Los Alamos, New Mexico, on Oct. 27 and 28, 1960. Fourteen out of 31

SCR's exhibited firing at gamma radiation rates between $6 \times 10^5$ and $3 \times 10^6$ r/sec. The gamma-induced SCR leakage current at firing generally exceeded twice the initial holding current of the device. A possible method for predicting gamma rates for firing SCR's is indicated. An empirical relationship for dependence of SCR leakage current ($I_c$ in amperes) on gamma rate ($\dot{\phi}$ in r/sec) was determined as $I_c = (6 \pm 3) \times 10^{-10}\ \dot{\phi}^{1.2 \pm 0.1}$. Leakage resistance change factors ($R_{min}/R_0$) as low as $3.6 \times 10^{-8}$ and $2.6 \times 10^{-7}$ for tantalum and aluminum electrolytic capacitors, respectively, were noted at gamma radiation rates up to $4.5 \times 10^7$ r/sec. A relationship between capacitor leakage resistance (R in ohms), capacitance (C in farads), and gamma radiation rate ($\dot{\phi}$ in r/sec) was determined at $R = G/\dot{\phi}C$, where $C = 2.1 \times 10^5$ for aluminum foil capacitors, $3.29 \times 10^5$ for tantalum foil capacitors, and $1.81 \times 10^5$ for tantalum solid electrolyte capacitors. This relationship does not apply for tantalum capacitors at times past the peak intensity of a radiation pulse due to long-time decay relationships which were determined. Charge generation effects due to gamma radiation were observed and interpreted for coaxial cables and uncharged capacitors. (auth)

**7307** (NRL-5984) NEUTRON EMBRITTLEMENT OF REACTOR PRESSURE VESSEL STEELS. L. E. Steele and J. R. Hawthorne (Naval Research Lab., Washington, D. C.). Oct. 22, 1963. 36p. (AD-423526)

This report presents the status of observations on the embrittlement of steels which are commonly used for the primary pressure containment vessels of nuclear power plants. The demonstrated criterion of nil ductility transition (NDT) temperature provides the basis for meaningful analysis of neutron-induced embrittlement in reactor steels. Results to date indicate that the degree of embrittlement depends upon the material, the neutron exposure, and the temperature during irradiation. These same variables also affect the degree of notch ductility recovery effected by postirradiation heat treatment. In addition, the time and temperature of heat treatment are shown to play an important role in establishing the recovery pattern. The validity of these experimental observations is being tested through correlations with data from reactor surveillance programs and from specimens of the SL-1 reactor pressure vessel. Preliminary data from dosimetry in the SM-1A reactor permit the extension of experimental data to predict the increase in NDT of the reactor pressure vessel. (auth)

**7308** (USAELRDL-TR-2310) TRANSIENT AND STEADY-STATE NUCLEAR RADIATION EFFECTS ON GERMANIUM PNP ALLOY TRANSISTORS. Edwin T. Hunter and Harry E. Wannemacher (Army Electronics Research and Development Lab., Fort Monmouth, N. J.). Oct. 1962. 23p. (AD-296283)

Procedures and results of nuclear irradiations made on germanium alloy transistors are reported. The facilities used were the Penn. State University Reactor and the Sandia Pulsed Reactor. Transient results of $I_{CBO}$ changes indicate dependence on applied voltage, with a resultant effective shunt resistance of 200 K. Changes in gain and in minority carrier lifetime were used to compute damage constants from data taken at both facilities. A factor of three is observed between the constants. Leakage current measurements and gain measurements are reported as functions of $f\alpha$. (auth)

**7309** (VDIT-16(3.4)) RADIATION EFFECTS ON SOLID, URANIUM-BASED NUCLEAR FUEL MATERIALS. Vol. 3, No. 4. A Bibliography. W. Uhlmann (Aktiebolaget Atomenergi, Stockholm). Oct. 1963. 49p.

A total of 76 abstracts is arranged under the headings General, Metallic Uranium, Alloys, Oxide Ceramics, Carbides and Other Refractory Compounds, and Dispersion Fuels. Subject and author indexes are included. (D.L.C.)

**7310** (WAPD-261) IRRADIATION BEHAVIOR OF BULK $B_4C$ AND $B_4C$ + SiC BURNABLE POISON PLATES. R. G. Gray and L. R. Lynam (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Oct. 1963. Contract AT(11-1)-Gen-14. 121p.

Zircaloy-clad elements of bulk $B_4C$ and $B_4C$–SiC were irradiated in pressurized hot water loops and in the Materials Testing Reactor (MTR) process water to depletions as high as 97% burnup of the boron-10 atoms present. The $B_4C$ showed a linear volume swelling rate of approximately 0.15% $\Delta V$ per $10^{20}$ depletions/cc up to about $90 \times 10^{20}$ depletions/cc after which a more rapid swelling occurred as a result of $B_4C$ cracking. Elements containing $B_4C$–SiC showed greater thickness changes as a result of SiC cracking. A severe decrease in hot water corrosion resistance occurs during irradiation of the bulk $B_4C$ and $B_4C$–SiC poison cores, resulting in disintegration of these poison cores when exposed to the water environment in-pile. $B_4C$ plate-type poison elements show greater thickness increases than would be expected from poison core volume swelling because of the formation of poison core-cladding gaps in the elements. The element swelling was extremely sensitive to fabrication variables. Helium gas released from $B_4C$ during irradiation was slight and not related to gas diffusion. Lattice parameter values obtained on irradiated natural $B_4C$ indicated that the $a_0$ direction of the hexagonal $B_4C$ remained essentially constant while the $c_0$ direction decreased with increasing boron-10 depletion. Evidence of plasticity of $B_4C$ in-pile was noted. The irradiation behavior of the ceramic materials studied in this investigation and the wrought alloy of B-10 austenitic stainless steel poisons are compared. (auth)

**7311** SELF IRRADIATION EFFECTS IN STABILIZED $\delta$ PLUTONIUM. E. King (Atomic Energy Research Establishment, Harwell, Berks, Eng.), J. A. Lee, K. Mendelssohn, and D. A. Wigley. Acta Met., 12: 111-12(Jan. 1964).

Evidence of saturation in 4% Al $\delta$ stabilized Pu after holding it at 5°K for over 7000 hr is reported. After 7000 hr at ~ 5°K, the rate of increase in resistance of $\delta$ Pu was still over 25% of its initial value. It was also noted that the rates of resistance increase do not follow a true exponential law of the form $\partial\rho/\partial t$ ($\rho$ saturation $\bar{\ }\rho$). (P.C.H.)

**7312** ELECTRIC EFFECTS OF IRRADIATION IN RHOMBIC CRYSTALS OF SULFUR. Sergio Costa Ribeiro and Preston V. Murphy (Comissao Nacional de Energia Nuclear, Rio de Janeiro). Anais Acad. Brasil. Cienc., 35: 159-64(June 1963). (In Portuguese)

Single crystals of rhombic sulfur of dark conductivity less than $5 \times 10^{-18}\ \Omega^{-1} - cm^{-1}$ were exposed to $Sr^{90}$ beta rays. The induced conductivity was proportional to beta ray dose rate and to electric field; the induced conductivity was $3 \times 10^{-13}\ \Omega^{-1} - cm^{-1}$ for a dose rate of 590 rad-mm$^{-1}$. The temperature dependence of induced conductivity gave activation energies of 0.1 and 0.05 ev for two different crystals. A persistent internal polarization was induced by simultaneous action of electric field and radiation. The decay of polarization followed an exponential relationship with an activation energy of 0.92 ev at 19°C and 0.88 ev at 0°C. (auth)

**7313** EFFECT OF LOW-TEMPERATURE ELECTRON IRRADIATION ON YOUNG'S MODULUS OF PURE Cu. D. Keefer and A. Sosin (Atomics International, Canoga

Park, Calif.). Appl. Phys. Letters, 3: 185-7(Nov. 15, 1963). (TID-19313; SCDC-3341)

A Cu sample was irradiated at 20°K with 1.0- to 0.35-Mev electrons. The sample, 0.13 mm thick, gave a degradation of about 0.25 Mev. An increase in the modulus was observed from electrons as low as 0.40 Mev. (R.E.U.)

**7314** OXYGEN-DEFECT COMPLEXES IN GERMANIUM. R. W. Whan and H. J. Stein (Sandia Lab., Albuquerque, N. Mex.). Appl. Phys. Letters, 3: 187-9(Nov. 15, 1963).

Optical evidence for the existence of oxygen-vacancy complexes in irradiated germanium is presented. It is established by the different annealing properties of the radiation-induced absorption bands. (R.E.U.)

**7315** EFFECT OF COBALT-60 GAMMA RADIATION ON COALS. II. CHANGES IN PHYSICAL AND CHEMICAL PROPERTIES. K. Ōuchi, Y. Kawana, T. Masuda, N. Yūki, S. Toyoda, Y. Sanada, K. Yamaguchi, Y. Yoshida, and H. Honda (Resources Research Inst., Kawaguchi, Saitama, Japan). Fuel, 42: 105-112(Mar. 1963).

Two coals were irradiated by cobalt-60 γ radiation ($10^4$ curies) for three to 150 hours (up to 46 megaroentgens). After irradiation, proximate and ultimate analyses, microhardness, Gieseler plasticity, and crucible swelling test showed no change, but the primary tar became heavier in character; the swelling ratio for Yūbari coal increased a little; benzene extract yield showed a maximum at 50 hr-irradiation time; the differential curves of water yield and of thermogravimetric measurement became sharper, and differential thermal analysis curves exhibited changes. The results indicate that degradation and polymerization reactions take place simultaneously. (auth)

**7316** EFFECT OF 14-Mev NEUTRON BOMBARDMENT ON DISORDERED REGIONS IN n-TYPE GERMANIUM. N. Urli and M. Zuppa. Glasnik Mat.-Fiz. Astron., Ser. II, 17: 223-32(1962).

Data obtained using a space charge model are analyzed and the model was checked. Low fluxes, time integrated doses up to $10^{14}$ neutrons per $cm^2$, and the use of relatively pure specimens with the initial carrier concentration on $n_0 < 10^{15}$ $cm^{-3}$ are discussed. Hall and resistivity measurements were performed before and after irradiations and are tabulated. It was concluded that the model seems to be quite plausible. (P.C.H.)

**7317** THE INFLUENCE OF TRAPPING LEVELS ON THE RECOMBINATION IN n-TYPE GERMANIUM IRRADIATED WITH GAMMA RAYS. Branko Celustka. Glasnik Mat.-Fiz. Astron., Ser. II, 17: 233-42(1962).

The effects of high-energy gamma irradiation on the hole life time of a single crystal of n-type Ge are reported. Attempts were made to identify and locate the recombination and trapping centers introduced by gamma irradiation. The results are discussed. (P.C.H.)

**7318** THE FLUX-LEVEL EFFECT IN RADIATION DAMAGE IN GRAPHITE. W. N. Reynolds and P. A. Thrower (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 10: 209-14(Nov. 1963). (AERE-R-4316)

Evidence for flux level effects in high flux neutron irradiation damage in graphite is discussed in terms of the results of transmission electron microscopy, which reveals resolvable interstitial clusters. The clusters are shown to be most naturally accounted for by a homogeneous nucleation model. Insofar as the properties studied depend on the presence of the clusters and of the isolated single vacancies from which they arise, it is shown that this model is fully consistent with the equivalent irradiation temperature correction for flux level effects up to 300°C in DIDO. Flux level effects are not expected and have not been reported, at higher temperatures, at any rate until vacancy nucleation becomes important. It is suggested that the lines of argument adopted may be of value in establishing consistent dose scales and in investigating possible flux level effects in other materials. (auth)

**7319** EFFECTS OF NEUTRON IRRADIATION ON THE THERMAL CONDUCTIVITY OF NUCLEAR GRAPHITE. M. Bocquet and G. Micaud (Centre d'Etudes Nucléaires, Saclay, France). J. Nucl. Mater., 10: 215-23 (Nov. 1963). (In French)

Two instruments are described that are used to measure the thermal conductivity of irradiated graphites. One uses the principles of heat transfer and permits the thermal conductivity to be measured near room temperature. The other relies on the method due to Kohlrausch and provides a measure of the conductivity as a function of temperature. Samples taken from the body of graphite-moderated reactors were examined. From the measurements, the variation of $(K_0/K_i)-1$ with the dose was determined for various irradiation temperatures. $K_0$ and $K_i$ are thermal conductivities before and after irradiation, respectively. At the same time, curves giving, for various doses, the variation of $(K_0/K_i)-1$ with irradiation temperature were determined. The results agree satisfactorily with those previously published by others. The variation of the thermal conductivity with the temperature of measurement was studied on samples of reactor-grade graphite irradiated at various temperatures in a heavy-water reactor. Measurements were carried out on each sample from ambient temperatures up to the temperature at which it had been irradiated. From the results it was possible to deduce, for each type of graphite investigated, the variation of $(K_0/K_i)-1$ as a function of the irradiation temperature and the temperature of measurement. (auth)

**7320** EFFECT OF MICROSTRUCTURE ON THE IRRADIATION BEHAVIOUR OF BERYLLIUM OXIDE. B. S. Hickman and D. G. Walker (Australian Atomic Energy Commission Research Establishment, Sydney). J. Nucl. Mater., 10: 243-5(Nov. 1963).

Studies were made on the effects of radiation on beryllium oxide of various grain sizes and densities. Examination of two fine-grained materials by both optical microscopy and replica electron microscopy failed to show any evidence of microcracking at doses up to and including $10^{21}$ nvt, even though the macroscopic volume change amounted to 4–5% at $10^{21}$ nvt. Further confirmation of the superiority of fine-grained material was obtained from x-ray measurements. The results suggest that grain size and intergranular stress are related. (P.C.H.)

**7321** THE DEPENDENCE UPON THE IRRADIATION DOSE OF THE APPARENT DIFFUSION RATES OF XENON IN URANIUM DIOXIDE. G. Frigerio and T. Gerevini (FIAT, Turin). J. Nucl. Mater., 10: 251-2(Nov. 1963).

A remarkable decrease in the apparent diffusion rates of Xe in $UO_2$ pellets with increase of the irradiation dose was observed in post-irradiation annealing experiments. Significant data on the effects are tabulated. (P.C.H.)

**7322** THE INFLUENCE OF NEUTRON IRRADIATION ON SOME MECHANICAL AND STRUCTURAL PROPERTIES OF AUSTENITIC CHROME–NICKEL STEELS. Jiří Červášek and Ján Kuťka (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Řež). Jaderna Energie, 9: 342-6(Nov. 1963). (In Czech)

The change of mechanical and structural properties of 13 kinds of anticorrosive steels of Cr–Ni type exposed to an integral dose of $1.6 \times 10^{19}$ n/cm$^2$ (E > 1 Mev) was investigated. The dose was held at a constant value and the Ni and Cr contents varied. Strengthening was observed, i.e., yield point, strength, and hardness increased and plasticity decreased at the same time. The rate of strengthening was independent of chemical composition, however it depended on the physical condition of steel before irradiation. As far as the alloying elements do not influence the initial condition of the steel, they exercise no influence on the radiation stability. Ferromagnetic induction measurement indicated the decrease in corrosion resistance of austenitic steels by radiation to be negligible. Transient austenitic-ferritic structure steels only showed a 0.43 to 0.72% increase in magnetic phase caused by $\gamma \rightarrow \alpha$ decay. (auth)

**7323** NATURE OF RADIATION DEFECTS IN SILICON SINGLE CRYSTALS. Haruo Saito and Mitsuji Hirata (Osaka Univ.). Japan J. Appl. Phys., 2: 678-87(Nov. 1963).

Floating zone silicon single crystals containing phosphorus were irradiated with cobalt-60 γ rays or 2-Mev electrons at room temperature. Temperature dependence of the Hall coefficient after irradiation showed the presence of two net acceptor levels, 0.17 and 0.38 ev below the conduction band. The introduction rate of the deep level increased with increasing phosphorus concentration, while that of the shallow level slightly decreased with increasing phosphorus concentration. The activation energy for the annealing of the 0.38-ev level was found to be 0.94 ev in the temperature range, 120–180°C. The results obtained can be successfully explained, if the Watkins' model is adopted. (auth)

**7324** THE EFFECTS OF NUCLEAR RADIATION ON TEXTILE MATERIALS. III. ON THE CHANGE OF TEXTILE PROPERTIES OF URYLON. Shigeo Ogawa, Sumiko Hasegawa, and Atsuo Konda. Kogyo Gijutsuin Sen'i Kogyo Shikensho Kenkyu Hokoku, No. 63, 19-25(Mar. 1963). (In Japanese)

Urylon (polyurea fiber) samples of 80-D unelongated, 2.7-D elongated by heat treatment at 140°C, and 2.4-D crimp staple were washed in $CH_3OH$ in a Soxhlet extractor, dried, and sealed in test tubes. They were γ-irradiated by a $Co^{60}$ source at dosage rates from $4.1 \sim 3.6 \times 10^3$ r/hr up to a maximum dosage of $4.9 \times 10^6$ r at room temperature. Their mechanical and optical properties were studied. The tenacities, elongations, and intrinsic viscosities decrease exponentially with increasing dosages. The crimping characteristics, however, have no remarkable changes due to irradiation. An equation that explains these changes on the basis of the molecular structure is: $\Delta n = X(\Delta n_c) + (1 - X)(\Delta n_a)$, where $\Delta n$ is the total birefringence, $\Delta n_c$ the birefringence due to the crystal part, $\Delta n_a$ the birefringence due to chain configuration in the amorphous part, and X the degree of crystallinity. (OID)

**7325** ON THE γ-RAY IRRADIATION EFFECTS OF PbS PHOTOCONDUCTIVE CELL. Katsuya Yamaguchi. Oyo Butsuri, 31: 364-7(May 1962). (In Japanese)

A PbS photoconductive cell with high resistance was irradiated at about 300°K by a 10000-C $Co^{60}$ source in the energy region of 1.33 and 1.77 Mev. The radiation dosage of the 1st exposure was up to $1.2 \times 10^7$ r, and the 2nd after 3 months was $10^8$ r. The relations of transmission of cell vs light frequency, variation of dark impedance vs time, variation of activation energy vs time, variation of time constant vs time, darkcurrent vs bias voltage, photocurrent vs bias voltage, and total noise vs bias voltage were graphed. It was found that: the recovery time of the various photoconductive characteristics was proportional to the radiation dosage; the darkcurrent increased and the photocurrent decreased by γ-irradiation; and radioinduced coloring of the cell vessel did not affect the cell function as it did in the case with an infrared ray detector. (OID)

**7326** ON THE DETERIORATION OF Ge PHOTOTRANSISTOR DUE TO γ-RAY IRRADIATION. Katsuya Yamaguchi. Oyo Butsuri, 31: 367-8(May 1962). (In Japanese)

A Ge phototransistor, OCP-71, was irradiated under 1.17 and 1.33 Mev γ rays with a $10^4$-C $Co^{60}$ source up to $1.2 \times 10^7$ r at 300°K. Graphs on the reverse voltage vs photocurrent, reverse current, and total noise before irradiation, and 24, 216, and 312 hr after irradiation were compared with that of the PbS photocell. It was found that irradiation induced more severe deterioration, the darkcurrent (reverse current) increment was greater, and the photocurrent was completely recovered after removal of irradiation; however, the reverse current and noise remained. (OID)

**7327** THE DAMAGE OF CRYSTALS BY COLLIMATED FISSION FRAGMENTS. F. P. Bowden and P. E. Caspar (Cavendish Lab., Cambridge, Eng.). Phil. Mag. (8), 8: 2091-5(Dec. 1963).

An experiment is described for determining crystal damage due to uranium fission fragments. An electron microscope was used to examine the crystal. Results are shown for molybdenum disulfide for both collimated and uncollimated fission fragments. (R.E.U.)

**7328** EFFECTS OF NEUTRON IRRADIATION ON THE YIELD STRENGTH AND GRAIN SIZE RELATIONSHIP IN IRON AND IRON–CARBON ALLOYS. J. G. Y. Chow and S. B. McRickard (Brookhaven National Lab., Upton, N. Y.). Phil. Mag. (8), 8: 2097-9(Dec. 1963). (BNL-7029)

It is concluded that neutron irradiation results in changes of both Petch parameters $\sigma_i$ and $k_y$. Changes in $\sigma_i$ are produced at relatively low exposures whereas changes in $k_y$ are only at higher exposures. The effect of carbon is to increase the exposure level at which a change in $k_y$ is noted. Results are given for pure iron, Fe–0.03C, and Fe–0.11C. (R.E.U.)

**7329** PRODUCTION OF DISPLACEMENT RADIATION EFFECTS BY RECOILS FROM PHOTONEUTRON REACTIONS. E. G. Wikner and V. A. J. van Lint (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Rev., 133: A884-90(Feb. 3, 1964).

The photoneutron method of producing displacement radiation effects was established. The displacement effects produced by recoils from Si(γ,n) reactions were detected by measurement of the change in excess-carrier lifetime. The change in the reciprocal of the lifetime is approximately proportional to the total number of primary reactions at various irradiating bremsstrahlung energies between 15 and 38 Mev, with a proportionality constant of $(2.0 \times 10^{-4} \pm 25\%)$cm$^3$sec$^{-1}$. The data can be explained on the basis that the primary energy loss of the recoil atoms is due to ionization. Other possible explanations are offered, and a comparison of the results with those of 30-Mev electron irradiations is made. (auth)

**7330** NEUTRON IRRADIATION EFFECTS ON THE MAGNETIC PROPERTIES AND STRUCTURE OF THE HIGH-PERMEABILITY FERRITES OF MANGANESE AND LITHIUM. Elena Labusca, N. Andreescu, and C. Motoc. Rev. Roumaine Met., Acad. Rep. Populaire Roumaine, 8: 183-94(1963). (In French)

The effects of neutron irradiations on magnetic materials of ferrite type C (having rectangular hysteresis curves) and type P (having high permeabilities), are studied. Irradiations carried out to $10^{18}$ neutrons/cm$^2$ produce only slight modifications in the properties of C-type ferrites, but in P-type ferrites the value of $\mu$ is reduced by as much as 35%, as a function of the flux intensity. Electron microscope studies of the radioinduced modifications shows the appearance of fibrous and granular structures, caused by thermal spikes and displacement spikes. It must be noted that the fibrous structures have lengths up to 1000 Å, and that dislocation loops are produced with some frequency. The results confirm a hypothesis concerning the resemblance between the behaviors of ferrites and of metallic, "soft" magnetic materials. (tr-auth)

**7331** CHANGES IN CERAMIC MATERIALS ON IRRADIATION. V. M. Belousov (Tomsk Polytechnic Inst., USSR). Steklo i Keram., No. 8, 40-4(Aug. 1963).

A discussion is presented on the effects of various types of irradiation on ceramics, including industrial and other applications of ceramics under radiation fields. Included are such applications as ceramic containers for nuclear reactor fuel elements, shields to prevent corrosion of metallic parts in vicinity of reactors, crucibles for smelting thorium, uranium, and other active metals, containers for radioactive wastes, and cermets. (OTS)

**7332** EFFECTS OF GAMMA RADIATION ON THE PUMPING SPEED CHARACTERISTICS OF DC-704 FLUID. O. H. Hill (General Dynamics Corp., Fort Worth, Tex.). Vacuum, 13: 313(Aug. 1963).

Three samples of Dow Corning 704 were irradiated to nominal exposed gamma doses of $10^6$, $10^7$, and $10^8$ r at 33°C. Pumping-speed measurements were performed in an intermediate-size Consolidated Vacuum Corp. PMC-720 diffusion pump. It is concluded that DC-704 can be used as a diffusion pump fluid in fields of up to $10^8$ r. (R.E.U.)

**7333** INVESTIGATIONS OF THE EFFECTS OF NEUTRON AND $He^3$ IRRADIATION ON THE MAGNETIC PROPERTIES OF PERMALLOY THIN FILMS. A. I. Schindler and C. M. Williams (U. S. Naval Research Lab., Washington, D. C.). 10p. (CONF-342-3)

From Conference on Magnetism and Materials, Atlantic City, Nov. 1963.

Measurements were made of the changes in the magnetic anisotropy energy and hysteresis loop parameters of evaporated permalloy thin films resulting from 2.2 Mev $He^3$ and reactor neutron irradiation. Only minor changes were observed following an irradiation of $1.6 \times 10^{14}$ $He^3$ part/cm$^2$. However, a total irradiation of either approximately $10^{17}$ neutrons/cm$^2$, or 8 to $9 \times 10^{16}$ $He^3$ part/cm$^2$, regardless of the magnetic state of the sample, increased the uniaxial anisotropy energy, $K_u$, up to 200% in a zero applied field. Similar increases were noted as a result of either neutron irradiation with a saturating magnetic field along the easy axis or $He^3$ irradiation with a saturating magnetic field either parallel or perpendicular to the easy axis. A decrease of ~ 50% in $K_u$ resulted from neutron irradiation when the saturating magnetic field was applied perpendicular to the easy axis. More significant hysteresis loop modifications observed were the development of constricted loops (measured in the hard direction) for most of the samples irradiated in zero applied field, and decreases in the coercive force up to 28% (measured in the easy direction) of most of the irradiated samples. (P.C.H.)

**7334** STUDY OF ENERGY LEVELS IN HIGH ENERGY PROTON DAMAGED SILICON. J. R. Carter, Jr. (TRW Space Technology Labs., Inc., Redondo Beach, Calif.). 14p. (CONF-363-12)

From International Symposium on Plasma Phenomena, San Diego, Calif., Oct. 1963.

The electrical nature of defects introduced in n- and p-type silicon by 10 to 40 Mev proton bombardment was investigated by Hall effect and compared to defects resulting from electron damage. Evidence of three types of electrically active defects is presented. The defects are: a net acceptor at $E_c - 0.17$ ev; a net acceptor at $E_c - 0.4$ ev; and a net donor at $E_v + 0.29$ ev. The defects appear to be identical to those previously reported for high energy electron damaged silicon. The damage introduction rates were estimated and found to be considerably larger than values reported for production of such defects by energetic electrons. (auth)

**7335** AN INFORMATION STORAGE AND RETRIEVAL SYSTEM FOR IRRADIATION EFFECTS IN METALS. Spencer H. Bush (Hanford Atomic Products Operation, Richland, Wash.). Metals Park, Ohio, American Society for Metals, 1963, Technical Report No. 19-3, 30p., $3.00. (CONF-356-2)

From 1963 American Society of Metals/Metals and Materials Show, Cleveland, Oct. 1963. 23rd National Convention of the Society for Nondestructive Testing.

An information storage and retrieval system (PIC) was developed, utilizing the IBM 7090 computer, for handling data pertaining to the effects of neutron irradiation on metals. The input includes a reference identification, an appropriate abstract or extract summarizing the article, code identification parameters analogous to those used by the ASM-SLA Literature Classification System, and special codes identifying relevant irradiation and testing parameters. The output contains the same data plus printing out the meaning of all special codes. Presently, the information storage consists of more than two hundred references representing several thousand lines of information. The system is both general and definitive, permitting the selection of a single piece of information or of many references dealing with a general field. It is possible to select material on the basis of one or more of the following factors: material, general or specific; type of literature; general or specific property such as mechanical tests or tensile tests; conditions of irradiation including type and level of flux, integrated flux, irradiation temperature, and reactor environment; test conditions such as temperature and environment; and general variables that might be controlling such as strain rate, specimen geometry, grain size, and fabrication history. It is felt that this system and the data systems will permit the rapid selection of relevant references once an optimum number of such references are available. (P.C.H.)

**7336** TEST TECHNIQUES FOR TRANSIENT RADIATION EFFECTS. V. A. J. van Lint and R. A. Poll (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Paper 1.4.2 of "Technical Papers." North Hollywood, Calif., Western Periodicals Co., 1963. 12p.

Examples of specific test techniques that were used in performing transient radiation effects measurements are given. The techniques were developed primarily for use with electron linear accelerators but can be applied directly in flash x-ray and pulsed reactor test programs as well. (auth)

# METEOROLOGY

**7337** STRATOSPHERIC MASS VARIATIONS AND FISSION PRODUCT RADIOACTIVITY IN SURFACE AIR. D. O. Staley (Univ. of Arizona, Tucson). J. Atmospheric Sci., 20: 615-21(Nov. 1963).

The relation between variations of stratospheric mass and the concentration of fission product radioactivity in surface air was studied by superposing time-latitude sections of the variables. Transport mechanisms are discussed (See NSA 17:4699). (R.E.U.)

# PHYSICS

## General

**7338** (CONF-303-13) GENERAL ASPECTS OF NUCLEAR HYPERFINE INTERACTIONS IN SALTS OF THE RARE EARTHS. R. L. Mössbauer (California Inst. of Tech., Pasadena). [1963]. Contract [AT(04-3)-41]. 31p.

From 3rd International Conference on the Mössbauer Effect, Ithaca, N. Y., Sept. 1963.

A discussion is presented of some of the general features encountered in recoilless resonance absorption studies of hyperfine interactions in salts of the rare earths. These features include interactions with the crystalline electric field, magnetic hyperfine interactions, invariance against time reversal, nuclear quadrupole interactions, and electronic shielding. Some experimental results are presented to illustrate the discussion. (D.L.C.)

**7339** (ISS-63/40) RIASSUNTI DELLE COMUNICAZIONI PRESENTATE AL 49° CONGRESSO NAZIONALE DI FISICA BARI, 6-13 NOVEMBRE 1963. (Summaries of the Papers Presented at the 49th National Congress of Physics, Bari, November 6-13, 1963). (Italy. Istituto Superiore di Sanita, Rome). Sept. 25, 1963. 24p.

Eight papers on single meson ($\pi^0$) photoproduction on protons, statistical analysis of excitation curves of recoil protons in photoproduction, meson ($\pi^-$) absorption in complex nuclei, 662-kev $\gamma$-ray scattering on bound electrons, search for radioactivity induced by tetraneutrons in stable isotopes, measurements on radiation emission by accelerated electrons in the Frascati synchrotron, acoustic detection of spark position in a cylindrical spark chamber, and a precision trigger circuit are summarized. (auth)

**7340** (NP-13461) A NOTE ON THE SATISFACTION OF BOUNDARY CONDITIONS BY THE SPECIFIC INTENSITY IN PROBLEMS OF RADIATION GASDYNAMICS. Ira M. Cohen (Brown Univ., Providence). Aug. 1963. For Johns Hopkins Univ., Silver Spring, Md. Applied Physics Lab. Contracts NOw 62-0604-c; Nonr(562)-3513, Subcontract 77797. 9p.

The specific radiant intensity is shown to satisfy the boundary conditions rather precisely. Both the transparent and optically thick gas approximations are considered. (D.C.W.)

**7341** (JPRS-21869) NEWS OF HIGHER EDUCATIONAL INSTITUTIONS, MINISTRY OF HIGHER AND SECONDARY SPECIALIZED EDUCATION USSR, RADIOPHYSICS SERIES. Translation of Izvestiya Vysshikh Uchebnykh Zavedenii, Radiofizika, 6: No. 2, 207-422(1963). 469p. (OTS-63-41139)

Subjects included in the articles are as follows: induced and spontaneous emission; lunar r-f emission; ground-wave propagation in the centimeter band; radiation of a charge in an inhomogeneous medium with spatial dispersion; theory of frequency doubling in ferrites; molecular beam polarization in electric fields; electromagnetic wave scattering by a statistically uneven surface; electromagnetic field in a plasma; spectrum of a quasi-harmonic signal; shock waves in transmission lines with thin layers of ferrite; multi-row interdigital slow-wave system; electromagnetic wave diffraction by a plane metallic grating lying on a dielectric layer; electromagnetic wave diffraction by a flat screened grating; wave dispersion in a helix of rectangular cross section; effect of delay in coupling forces on hysteresis processes in complex self-oscillating systems; simulation of variable delay on magnetic tape; r-f emission omission by Cassiopeia A and Cygnus A; rigid parabolic antenna; beam instability in a plasma; electromagnetic wave absorption; radiation of a charge incident on a metallic sphere; energy losses of a charge moving over a periodic uneven surface; radiation reaction of a charge moving along a periodic trajectory in a waveguide; reflection of electromagnetic shock waves; and width of the line of a self-oscillator. Separate abstracts were prepared for 5 of the papers. (R.E.U.)

*For abstracts of individual papers see: 7342, 7562, 7791, 7792, and 7793.*

**7342** (JPRS-21869(p.429-36)) REACTION OF RADIATION WHEN A CHARGE MOVES ALONG A PERIODIC TRAJECTORY IN A WAVE GUIDE. V. K. Yulpatov. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 6: 410-13(1963).

The motion of a particle along an arbitrary periodic trajectory in any wave guide is generalized with anisotropic filling and impedance walls. The electromagnetic field is represented in the form of a Fourier integral and the work performed by the radiation field on the particle during one period of motion is determined. The current density of the particle is represented. (R.E.U.)

**7343** (UCRL-Trans-993(L)) ON ONE METHOD OF NUMERICAL SOLUTION OF CERTAIN NONLINEAR PROBLEMS OF AEROHYDRODYNAMICS. A. A. Dorodnitsyn. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Livermore), from Tr., Vses. Mat S'ezd, 3: 447-53(1958). 12p.

The straight line method in which systems of equations in partial derivatives are reduced to systems of ordinary differential equations is outlined, and some examples of solutions by the method are examined. The method is particularly suitable for solution of two-dimensional, purely supersonic aerodynamic problems on fast computers. (D.C.W.)

**7344** LASER-STIMULATED RAMAN EFFECT AND RESONANT FOUR-PHOTON INTERACTIONS IN GASES $H_2$, $D_2$, AND $CH_4$. R. W. Minck, R. W. Terhune, and W. G. Rado (Ford Motor Co., Dearborn, Mich.). Appl. Phys. Letters, 3: 181-4(Nov. 15, 1963).

The output of a giant-pulsed ruby laser was focused into a cell containing the gas, and the output radiation was analyzed. In $H_2$ it is found that the frequency difference between lines corresponds to a particular vibration-rotation transition of the molecule. Some evidence for pure rotational transitions in $D_2$ was obtained. The resulting spectra in all cases appeared as if a diffusion of energy by discrete steps in frequency space had occurred. (R.E.U.)

**7345** RADIATIVE TRANSFER OF ENERGY BETWEEN RARE-EARTH IONS. A. Y. Cabezas and L. G. DeShazer (Hughes Aircraft Co., Culver City, Calif.). Appl. Phys. Letters, 4: 37-9(Jan. 15, 1964).

Energy transfer between two rare-earth dopants in glass was observed. In a Tb–Dy: borosilicate glass (3 wt % of each rare earth oxide) the $Tb^{3+}$ fluorescence was enhanced by 70% by additional excitation from $Dy^{3+}$. The energy transfer is radiative, i.e., the fluorescence from one dopant absorbed by the other leads to increased fluorescence in-

tensity from the latter; in effect, the number of pump bands of $Tb^{3+}$ has been increased. Other pairs were studied, and a means of improving laser efficiency is suggested. (R.E.U.)

**7346** A FINITE DIFFERENCE ANALYSIS OF LAMINAR MAGNETO-HYDRODYNAMIC FLOW IN THE ENTRANCE REGION OF A FLAT RECTANGULAR DUCT. Ching-lai Hwang and Liang-tseng Fan (Kansas State Univ., Manhattan, Kan.). Appl. Sci. Res., Sect. B, 10: 329-43 (1963).

The development of the velocity profile, from a uniform one at the entrance, for an electrically conducting fluid entering a semi-infinite flat duct with a transversely applied magnetic field is investigated. It is assumed that the fluid has constant physical properties, the duct walls are electrically nonconducting, a uniform magnetic field is imposed perpendicular to the duct walls, and there can be a net electrical current flow parallel to the walls and perpendicular to the flow direction with a variable external resistance connecting the two side plates, which are displaced at infinity. The basic governing continuity and momentum equations are expressed in finite difference form and solved numerically on a high-speed digital computer with a mesh network superimposed on the flow field. A practical mesh size ratio suitable for computation was determined. Results were obtained for the variations of velocity and pressure distribution between the inlet and the region for the fully developed velocity profile for Hartmann numbers of 0, 4, and 10. (auth)

**7347** ION ROCKETS. A. Theodore Forrester and Stanton L. Eilenberg. Intern. Sci. Technol., No. 25, 52-3; 56-61(Jan. 1964).

The requirements and performance of ion engines of only a few pounds thrust are discussed. Methods for ionization of atoms for use in the engines are described. Colloidal-particle engines are also discussed. (R.E.U.)

**7348** COMPRESSION AND REFLECTION OF BRILLOUIN BEAMS. E. A. Ash (Standard Telecommunications Labs. Ltd., Harlow, Eng.). J. Electron. Control (1), 15: 401-17(Nov. 1963).

The maximum rate of magnetic compression of a Brillouin beam is limited by the retardation experienced by the outer electrons. Equations describing the trajectories as a function of the assumed magnetic and electric field distributions, taking the retardation effects into account, are developed. It is shown that under certain circumstances, the procedure can be reversed and used to synthesize a magnetic field distribution from a prescribed beam trajectory. A similar approach is also applicable to the problem of reflecting a Brillouin beam by means of electric fields. Numerical results are presented for both cases. (auth)

**7349** AN EXPERIMENTAL STUDY OF PASSIVE PARAMETRIC INTERACTIONS BETWEEN TRANSVERSE ELECTRON BEAM WAVES. J. A. Lucken and C. W. Turner (Research Labs. of Electric and Musical Industries, Ltd., Hayes Middx., Eng.). J. Electron. Control (1), 15: 479-91(Nov. 1963).

Results are presented of experiments concerning the passive parametric transfer of signal power between transverse electron beam waves, under the action of quadrupolar electric pump fields. The results obtained clearly demonstrate the validity of the first-order theory of the passive parametric interactions, and lend some encouragement to present efforts to utilize these processes in schemes for cooling "slow" beam waves. Some discussion of the novel means adopted for observing these interactions is included. (auth)

**7350** FIVE-DIMENSIONAL RELATIVITY. J.-M. Souriau (Faculté des Sciences, Marseille). Nuovo Cimento (10), 30: 565-78(Oct. 16, 1963).

The hypothesis that the universe U is a five-dimensional Riemannian manifold that satisfies certain global topological conditions is studied. The existence of a principle of relativity that treats on equal basis the five dimensions of U is postulated; the laws that satisfy this principle have an approximate description in a 4-dimensional space-time manifold $\hat{U}$; this gives the possibility of comparing them with the usual description of experimental laws. Thus, if the invariance of general relativity is extended to the fifth dimension, classical electrodynamics is obtained: the equations of Maxwell, conservation of electricity, electromagnetic forces, etc. Likewise, the five-dimensional extension of the invariance of the wave equations leads automatically to electromagnetic terms, such as they are actually observed; the electric charge, for instance, is found to be an integral multiple of an elementary charge that depends neither on the mass, nor on the spin. Among the other consequences of the theory are gauge invariance and charge conjugation; the maximum violation of parity in $\beta$-decays; the existence of two neutrinos of opposite chirality. (auth)

**7351** ON DIFFRACTION CONTRAST AT PARTICLE TRACKS IN CRYSTALS. Lewis T. Chadderton (Cavendish Lab., Cambridge, Eng.). Phil. Mag. (8), 8: 2085-90(Dec. 1963).

The dark tracks produced by fission fragments in thick crystals due to rearrangement of material and localized perturbation of prevailing diffraction conditions are discussed. An electron microscope was used to observe the tracks. (R.E.U.)

**7352** THEORY OF TRANSPORT COEFFICIENTS. IV. ELECTRICAL CONDUCTIVITY IN THE PRESENCE OF A STRONG MAGNETIC FIELD. S. Fujita and F. Mayné (Université Libre, Brussels). Physica, 29: 1201-13(Nov. 1963).

The transverse electrical conductivity of an electron-phonon system under a strong static magnetic field is calculated up to the second order in the electron-phonon interaction starting from the Nakano-Kubo formula and using the Feynman diagram techniques. The result is in agreement with that obtained by Titeica from intuitive grounds. It is found that the initial electron correlations contained in the canonical distribution $\exp[-\beta(H_0 + H_1)]$ contribute to the conductivity in contradistinction to the case of a magnetic field-free system, where the (static) conductivity in general can be expressed in terms of asymptotic cross sections defined between states free from correlation. This fact necessarily implies the impossibility of properly describing the magnetoresistance on the basis of Boltzmann-like equations. (auth)

**7353** GENERALIZED CANONICAL FORMALISM FOR DEGENERATE DYNAMICAL SYSTEMS. S. Shanmugadhasan (National Research Council, Ottawa). Proc. Cambridge Phil. Soc., 59: 743-57(Oct. 1963).

Classical theory for degenerate dynamical systems is investigated. The canonical formulation of the dynamical equations in the degenerate case are examined. The mutual relation between degeneracy and the Lagrange equations of reduced order is studied. A change of variables from the velocities to the momenta is made and the hamiltonian is substituted for the lagrangian. (C.E.S.)

**7354** TECHNIQUES FOR SPUTTERING SINGLE AND MULTILAYER FILMS OF UNIFORM RESISTIVITY. L. I. Maissel and J. H. Vaughn (IBM Corp., Poughkeepsie, N. Y.). Vacuum, 13: 421-3(Oct. 1963).

A sputtering apparatus is described in which the substrate holding system is stationary while the cathode assembly is capable of rotation. This allows deposition of multiple films, without breaking vacuum between sputtering, and at the same time places no limit on the amount of wiring and plumbing that may be connected to the substrates. Point-to-point variations in the sheet resistivity of tantalum films are shown to be associated with the presence of oxygen in the sputtering gas and with temperature gradients in the plane of the film during its deposition. (auth)

**7355** PRODUCTION OF FAST MOLECULAR BEAMS USING GASEOUS MIXTURES. R. Klingelhoefer and P. Lohse (Technische Hochschule, Karlsruhe, Ger.). 16p. (CONF-290-3)

From Conference on Molecular and Atomic Gas Beams, Charlottesville, Va., May 1963.

Relatively fast molecular beams of heavy gases can be produced by having a mixture of the heavy gas and a light acceleration gas expand out of a nozzle and then by transferring the screened-out core of the beam into high vacuum. By mass spectrometric analysis of the collected beam, the degree of enrichment of the heavy gas is investigated for different argon–hydrogen mixtures and for different inlet pressures. The particle flow density of the molecular beam is obtained by measurement of the pressure head. The acceleration of argon is investigated by a time-of-flight method. For an initial mixture of 1% Ar and 99% $H_2$, the system yields a maximum of 40% for the argon mole fraction in the beam at an inlet pressure of 2 atm. The corresponding flow density is $1.3 \times 10^{17}$ Ar atoms per sq. cm sec at a distance of 60 mm from the nozzle; the beam velocity is 2,100 m/s corresponding to a kinetic energy of the argon atoms of about 1 ev. (auth)

**7356** MÖSSBAUER EFFECT IN $\beta$-TIN FOR $1.3 \leq T \leq 370°K$ (thesis). Christoph Hohenemser (Washington Univ., [St. Louis]). 66p. (CONF-303-14)

A Paper on this Dissertation was given at the 3rd International Conference on the Mössbauer Effect, Ithaca, N. Y., Sept. 1963.

The predicted dependence of the recoilless fraction of the emitting and absorbing nuclei on the Debye temperature was used to determine the Debye temperature in $Sn^{119}$ as a function of temperature for a polycrystal of $\beta$-Sn (white Sn) in the temperature range $1.3 \leq T \leq 370°K$. Qualitative conclusions are obtained about the nuclear quadrupole interaction, possible changes of the Debye temperature due to the onset of superconductivity, and the possible presence of Debye-dependent phase transitions generally. (R.E.U.)

**7357** SPACE RESEARCH. III. Proceedings of the Third International Space Science Symposium, Washington, D. C., May 2-8, 1962. Wolfgang Priester, ed. New York, Interscience Publishers, 1963. 1287p. $35.00.

This volume of the symposium which was organized jointly by the internal Committee on Space Research and the Space Science Board of the U. S. National Academy of Sciences, contains 118 papers on the upper atmosphere and exosphere of the earth and their relations to solar disturbances, the sun and interplanetary medium, the moon and planets, galactic and extra-galactic astronomy, the life sciences, and technologies of space research. Separate abstracts were prepared for 58 papers; 14 were previously included in NSA. (R.E.U.)

*For abstracts of individual papers see: 7012, 7087, 7088, 7390, 7391, 7392, 7393, 7394, 7395, 7396, 7397, 7398, 7399, 7400, 7401, 7402, 7441, 7442, 7443, 7444, 7445, 7446, 7447, 7448, 7449, 7450, 7451, 7452, 7610, 7611, 7612, 7613, 7614, 7615, 7616, 7617, 7618, 7619, 7620, 7621, 7622, 7623, 7624, 7625, 7626, 7627, 7628, 7629, 7630, 7631, 7632, 7633, 7634, 7635, 7636, 7637, 7638, and 7639.*

## Accelerators

**7358** (BNL-7368) RECENT STUDIES ON THE EXPERIMENTAL PROGRAM REQUIREMENTS FOR A SUPER-HIGH ENERGY ACCELERATOR. Luke C. L. Yuan (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 13p. (CONF-114-23)

From the International Conference on High Energy Accelerators, Dubna, U.S.S.R., Aug. 1963.

Some experimentation that might be performed with accelerators of ~1000 Bev is discussed, and some experimental considerations (induced radioactivity and a suitable bubble chamber) associated with these accelerators are presented. The results of calculations of the angular and momentum distributions of the secondaries produced in colliding beam (p-p) interactions are included. (D.C.W.)

**7359** (NP-13364) ÉTUDE DE LA TOPOGRAPHIE DU CHAMP MAGNÉTIQUE ET OPTIQUE DES TRAJECTORIES DE SORTIE DES PARTICULES DANS UN ACCÉLÉRATEUR FFAG DU TYPE OHKAWA (theses). (Study on the Topography of Magnetic Fields and Optics of Particle Orbits in a FFAG Accelerator of Ohkawa Type (thesis)). B. V. Robouch (Lyon. Université). [1961]. 83p.

The output trajectories of FFAG accelerators of the Ohkawa type were studied. The three magnetic parameters (magnetic induction field $\vec{B}$, vector potential field $\vec{A}$, and scalar potential field U) are defined with precision, and solutions, valid for the entire space and for all constant values of the index and of any azimuthal periodicity, are derived for them. It was shown that when the field index has an integral value, the solutions are reduced to simple analytical forms without the need of infinite series solutions. The form of the equipotential defining the polar pieces creating a field with constant index is briefly considered. The systems of coordinates for which the three fields derived from a scalar field will give the definition equation were defined. The present study can be subdivided into two parts. In the first part the simplifications that can be applied to the definition of magnetic topography are given. In the second part the equations of motion are set up by adopting the magnetic topography defined and the results obtained, after the numerical resolution of the equations of motion, on the output optics of accelerator trajectories are discussed. (J.S.R.)

**7360** (ORNL-3499(Vol.II)(p.24-5)) NUCLEON-MESON CASCADE CALCULATIONS: TRANSVERSE SHIELDING FOR A 45-Gev ELECTRON ACCELERATOR. R. G. Alsmiller, Jr., F. S. Alsmiller, and J. E. Murphy (Oak Ridge Gaseous Diffusion Plant, Tenn.).

Nucleon-meson cascade calculations performed for several cases of interest in the design of the transverse shield for the proposed 45-Bev linear electron accelerator at Stanford are discussed. (auth)

**7361** (ORNL-3499(Vol.II)(p.95-100)) SPACE, TIME, AND ENERGY DISTRIBUTIONS OF THE PROTON BEAM

FROM THE HARVARD UNIVERSITY SYNCHROCYCLOTRON. R. T. Santoro (Oak Ridge National Lab., Tenn.).

Measurements of the spatial distribution by x-ray film techniques and by profile telescope methods indicate that there was a normal distribution of protons across the beam, with 86% of the protons included in two standard deviations and a full-width at half-maximum at 6.6 mm. The beam cross section was circular. The cyclotron duty factor was found to be about 4%. From range-energy measurements, for which copper absorbers were used, the proton energy was found to be 160.9 Mev, while independent time-of-flight measurements resulted in a value for the energy of 154.4 Mev. (auth)

**7362** (ORNL-3499(Vol.II)(p.100-4)) MEASUREMENTS OF THE INTENSITY OF THE PROTON BEAM OF THE HARVARD UNIVERSITY SYNCHROCYCLOTRON FOR ENERGY-SPECTRAL MEASUREMENTS OF NUCLEAR SECONDARIES. R. T. Santoro and R. W. Peelle (Oak Ridge National Lab., Tenn.).

Two thin helium-filled parallel-plate ionization chambers were used to monitor the intensity of the 160-Mev beam during the spectral measurements described previously. The chambers were calibrated by two independent methods: by comparison with measurements of the absolute beam intensity made with a Faraday cup and by comparison with the results of direct counting of the protons in the beam by fast counting techniques. The two determinations were in agreement within <5%. A drift in the calibration of the chambers during the spectral runs was confirmed by measurements with an $Sr^{90}$ source and is ascribed to a gradual contamination of the helium filling gas by air leakage. (auth)

**7363** (ORNL-3499(Vol.II)(p.104-5)) PREPARATIONS AT ORIC FOR CONTINUED MEASUREMENTS OF ENERGY SPECTRA OF NUCLEAR SECONDARIES. R. T. Santoro (Oak Ridge National Lab., Tenn.).

The experimental space shielding program will be continued at the Oak Ridge isochronous cyclotron. Existing experimental apparatus is being modified for use with this accelerator, and the gamma spectrometer to be used in the first measurements of secondary spectra has been installed. (auth)

**7364** (PPAD-501E) THE RF SYSTEM FOR THE PRINCETON-PENNSYLVANIA ACCELERATOR. J. Kirchgessner, G. K. O'Neill, and J. Riedel (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Aug. 1963. Contract AT(30-1)-2137. 17p. (CONF-114-24)

From the International Conference on High Energy Accelerators, Dubna, U.S.S.R., Aug. 1963.

The small aperture necessitates operation on a high harmonic of the particle rotation frequency and maintenance of very close tolerances on amplitude, frequency, and phase. Also, the high repetition rate requires high r-f accelerating voltages. The system, its operation, and its performance are described. (D.C.W.)

**7365** (CEA-tr-R-1709) TRAVAUX SUR LES FAISCEAUX DE SENS OPPOSES ELECTRONS-ELECTRONS, POSITONS-ELECTRONS ET PROTONS-PROTONS A L'INSTITUT DE PHYSIQUE NUCLEAIRE DE LA FILLIALE SIBERIENNE DE L'ACADEMIE DES SCIENCES DE L'URSS. CONFERENCE SUR LES PARTICULES DE HAUTES ENERGIES, DUBNA, 1963. (Work on Electron-Electron, Positron-Electron, and Proton-Proton Colliding Beams at the Institute of Nuclear Physics of the Siberian Branch of the USSR Academy of Sciences, Conference on High Energy Particles, Dubna, 1963). G. I. Budker, A. A. Naumov, et al. (Akademiya Nauk S.S.S.R. Institut Yodernoi Fiziki, Novosibirsk). Translated by M. Vinogradoff from a Paper from Conference on High Energy Particles, Dubna, 1963. 41p.

The characteristics and designs of the three devices for the study of opposing electron-electron, positron-electron, and proton-proton beams are given and discussed. The accelerator injector, electron accumulator, electron optical guide, extraction and injection systems, and experimental conditions of the first two devices are described. The design, electronic mock-up, the magnetic system, and feed system of the proton-proton device are briefly illustrated. (J.S.R.)

**7366** STRAY AND SCATTERED RADIATION INTENSITY AND ENERGY DISTRIBUTIONS OF A 15 Mev BETATRON USED FOR NON-DESTRUCTIVE MATERIALS TESTING. Karl Liebknecht (Forschungsgruppe für Zerstörungsfreie Werkstoffprüfung im VEB Schwermaschinenbau, Magdeburg, Ger.). Kernenergie, 6: 577-84 (Oct. 1963). (In German)

An industrial betatron installed for nondestructive materials testing with 15-Mev boundary energy was investigated with regard to interfering and scattered radiation. The definitions of the dosimetry concepts used are explained. Commercial ionization chambers were used as radiation indicators and their measurement errors determined. The average energy was obtained from absorption measurements. For various planes relative to the target, isodoses were plotted, which showed strong asymmetrical distributions. The influence of the thickness and shape of the scattering body as well as the primary radiation energy was determined. (tr-auth)

**7367** MEASURING POSITION AND CURRENT OF AN ACCELERATED PARTICLE BEAM. L. Holcomb, D. I. Porat, and K. Robinson (Harvard Univ., Cambridge, Mass.). Nucl. Instr. Methods, 24: 399-407(Oct. 1963).

A system used in the measurement of particle beam position in the Cambridge Electron Accelerator is described. Pick-up coils with a band width of 30 kc to 10 Mc achieve sensitivities of 0.08 v/amp · cm along the horizontal coordinate of position of center of charge, the sensitivity along the vertical coordinate being 0.30 v/amp · cm. The sensitivity of the peak current measuring coil is 0.2 v/amp using a vacuum-core torus. (auth)

**7368** DATA LINK FOR ON-LINE OPERATION OF HIGH ENERGY PHYSICS EXPERIMENTS. J. P. Bounin and R. H. Miller (Univ. of Chicago). Nucl. Instr. Methods, 24: 408(Oct. 1963).

A multi-conductor cable set to permit on-line operation of a 450-Mev cyclotron with a digital computer is described. The cable has low noise, low crosstalk, and is inexpensive. (C.E.S.)

**7369** AN R.F. FIELD STABILISATOR SYSTEM FOR A LINEAR ACCELERATOR. C. W. Planner (Rutherford High Energy Lab., Chilton, Berks, Eng.). Nucl. Instr. Methods, 24: 409-10(Oct. 1963).

To attain stability on the Nimrod Injector Linac, a system was developed that produces fast automatic switching of large amounts of r-f power in response to low voltage error signals. The system was designed to switch r-f power of up to 700 kev for pulse widths of 0.1–2.5 msec. (C.E.S.)

**7370** ELECTRON ACCELERATION TECHNIQUE AND DESIGN OF AN INDUCTION ACCELERATOR. Bohumír Šusta. Czechoslovak Patent 97206. Nov. 15, 1960.

The design of a cyclic charged-particle accelerator is

proposed, in which electron acceleration is actuated with an eddy-current field (inductive emf) induced in an electroconductive ring cooled to the state of superconductivity. The ring is interposed between the poles of an electromagnet, and the electron source is provided by a continuous annular film inside the ring, made of a tin-bismuth alloy and cooled to the state of superconductivity by dipping the entire ring into liquid helium or by passing the latter through a circular channel in the insulated central part of the ring. Tungsten targets of a small rectangular plate design are placed at determined intervals along radii of the ring on the internal and external film surfaces. Throughout the time of electron acceleration, the ratio between the current strength in the electromagnet core and the circular field current strength remains constant. As a result, the electrons do not leave their equilibrium orbit. After electrons of the required energy have been obtained, in the auxiliary coil (in the electromagnet core), a current pulse is fed, the character of the magnetic field is changed, electrons leave their orbit, hit the targets, are slowed down, and gamma radiation is produced as a result. It is noted that the suggested method of acceleration and the cyclic accelerator design permit the electron beam intensity to be increased significantly, since the space charge is absent. (Referativnyy zhurnal, Fizika, No. 5, 1962)

## Astrophysics and Cosmology

**7371** CALENDAR RECORD FOR THE INTERNATIONAL GEOPHYSICAL COOPERATION 1959. Ann. Intern. Geophys. Yr., 16: 201-300(1963).

Solar and geophysical phenomena for the period Jan–Dec 1959 are given in summary form. Information is given on the level of magnetic activity, outstanding aurora, cosmic ray events, world blackout days, polar cap absorption events, solar phenomena, spectral radio emission, solar electron corona observation dates, and rocket, satellite, and space probe launchings. (C.E.S.)

**7372** EXCITATION CONDITIONS IN $H_{II}$ REGIONS IN SPIRAL AND IRREGULAR GALAXIES. G. R. Burbidge (Univ. of California, San Diego), R. J. Gould, and S. R. Pottasch. Astrophys. J., 138: 945-68(Nov. 15, 1963).

A review is given of possible explanations for the variation in the H$\alpha$/[NII] intensity ratio that decreases from ~3 in spiral arm regions to ~0.1 in the nuclear regions of some spiral galaxies. It is concluded that this behavior can be most easily understood in terms of an increase in the electron temperature from about 6000°K in spiral arm regions to about 20000°K in nuclear regions. The problem of the electron temperature in galactic HII regions is reinvestigated in the light of better data on element abundances and electron-ion collisional excitation cross sections. From the [OII]/H$\alpha$ and [OIII]/H$\alpha$ intensity ratios an electron temperature of roughly 6000°K is found for two diffuse nebulas in our galaxy. The heating and cooling processes are considered. A more accurate method for the calculation of the photoelectric heating rate yields values about 60 per cent as large as those computed by Spitzer. The cooling by electron-ion collisions is computed for the abundant ions. It is found that excitation of low-lying fine structure levels of the ground state term of a number of ions, especially $Ne^+$, leads to considerable cooling at moderate or low electron temperatures. The results of these calculations show that, for most spiral arm HII regions, equilibrium electron temperatures in the approximate range 4000 to 7000°K can be expected and that, under certain excitation conditions, temperatures as low as 1000°K may be attained. All considerations of electron temperatures in normal spiral arm HII regions seem to point to a temperature appreciably below the value 10000°K which has often been assumed. Possible mechanisms for the production of high (~20000°K) electron temperatures are considered. While photoelectric heating can definitely be ruled out, the ejection of particles from stars (probably in the form of clouds of plasma with proton energies above about a kilovolt) can produce the necessary heating without disrupting the observed ionization equilibrium in nuclei of galaxies. (auth)

**7373** X-RAYS FROM THE GALACTIC CENTER, EXTERNAL GALAXIES, AND THE INTERGALACTIC MEDIUM. R. J. Gould and G. R. Burbidge (Univ. of California, San Diego). Astrophys. J., 138: 969-77(Nov. 15, 1963).

The various mechanisms proposed to explain the cosmic x rays observed by Giacconi, Gorsky, Paolini, and Rossi are reviewed. It is shown that the electron-proton bremsstrahlung from a spectrum of energetic nonrelativistic electrons can account for the observed x rays from the direction of the galactic center, provided the total energy density of these electrons is greater than about one-hundredth of the energy density of the thermal particles in the center. If there is a flux of high energy particles (electrons or protons) in the galactic center, certain monochromatic x rays, from K-series transitions following a K-shell ionization, should also be emitted at an observable rate. Thus detailed observations in the x-ray region should give information about both the particle fluxes in the central region of the galaxy and the relative abundances of elements which give K-series x rays. It is also shown that the observed intensity of the isotropic background x rays is incompatible with the "hot universe" model of the steady-state cosmological theory, and that the intergalactic medium must have a temperature less than $10^7$ degrees if its density is as large as the value $2 \times 10^{-29}$ gm/cm$^3$ predicted by the steady-state theory. However, the observed intensity of these background x rays is comparable to that expected from all external galaxies, on the assumption that all galaxies emit x rays from their center at the same rate as our own galaxy. (auth)

**7374** AN ATTEMPT TO OBSERVE 21-CM LINE EMISSION FROM INTERGALACTIC HYDROGEN. Samuel J. Goldstein, Jr. (Harvard Univ., Cambridge, Mass.). Astrophys. J., 138: 978-87(Nov. 15, 1963).

Measurements were made of the relative brightness temperature over the frequency range 1400.4 to 1440.4 Mc in a 24 × 27° region centered on the north celestial pole. With the assumptions that intergalactic neutral hydrogen atoms have a Hubble parameter of 100 km/s/Mpc and that they are optically thin, the measurements yield an upper limit, $2.1 \times 10^{-5}$ atoms/cm$^3$, to the density of these atoms. Field has set an upper limit to the density of intergalactic neutral hydrogen atoms through an attempt to observe absorption in the spectrum of the source Cyg A. Field's measurements are rediscussed, and the assumption that this source and a reference source Cas A have constant spectral indices is omitted. The rediscussion gives an upper limit of $2.6 \times 10^{-5}$ atoms/cm$^3$. (auth)

**7375** THE OPACITY OF DIFFUSE COSMIC MATTER AND THE EARLY STAGES OF STAR FORMATION. John E. Gaustad (Princeton Univ., N. J.). Astrophys. J., 138: 1050-73(Nov. 15, 1963).

Several physical processes are examined that contribute

to the opacity of a protostar in the temperature range 50 to 3000°K. At low temperatures the opacity is produced by solid grains. Above 150° the volatile ices evaporate, but the residual refractory compounds in the grains still provide the major absorption. When the grains are completely evaporated (above 1300°) only hydrogen molecules and $H^-$ contribute to the opacity. It is shown that solid carbon is unlikely to form, and that absorption by molecules, both in vibration-rotation bands and in the vibrational continuum, is probably unimportant. Application is made to star formation, neglecting angular momentum and magnetic field considerations. For protostars greater than one tenth of a solar mass the opacity never becomes high enough to raise the internal temperature sufficiently to establish hydrostatic equilibrium. Hence no Helmholtz contraction phase exists; such a protostar collapses in free fall all the way to stellar densities. (auth)

**7376** EVOLUTION OF O STARS. I. HYDROGEN-BURNING. Richard Stothers (Harvard Univ., Cambridge, Mass., and Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 138: 1074-84(Nov. 15, 1963).

The evolution of an O-type star of 30 $M_\odot$ is considered from its initial main-sequence state to the point where the hydrogen content of the core has decreased from 70 per cent to 7 per cent by weight. The O stars are characterized by convective instability in the envelope and the full CNO-cycle of energy generation. Radiation pressure is important throughout the star, and electron scattering dominates the opacity. The inhomogeneous models consist of four zones: (I) a radiative envelope retaining the initial composition, (II) an outer semiconvective zone with a continuously varying composition that has a discontinuity at the interface with (III) an inner radiative zone also with a continuously varying composition, and (IV) a homogeneous convective core. Due to increasing radiation pressure, the semiconvective zone grows more rapidly outward than inward, but produces little effect on the important stellar quantities. The mass fraction of the core decreases from 0.69 to 0.34 and the mean hydrogen content of the star gets 40 per cent depleted. The age, 4.7 million years, is shorter than that for other sequences computed for stars of mass ≈30 $M_\odot$ because of a higher luminosity. This is mainly the result of choosing a higher mean molecular weight and CNO content. (auth)

**7377** NEUTRINO EMISSION, MASS LOSS, AND THE FREQUENCY OF SUPERNOVAE. Richard Stothers (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 138: 1085-9(Nov. 15, 1963).

Without steady mass loss during the red-giant phase, most stars with mass above the Chandrasekhar limit should evolve into Type II supernovas, but the predicted number of supernovas is much larger than the observed number. Although mass loss considerably lowers the predicted number, its effect will be reduced because of neutrino emission that decreases the time scale of the late phases. By use of presently known rates of stellar evolution and mass ejection, it is shown that loss of mass with or without neutrino emission will roughly account for the observed number of Type II supernovas. Thus neutrino emission is not contradicted by observations of supernova frequency. (auth)

**7378** MASSIVE STARS IN QUASI-STATIC EQUILIBRIUM. Icko Iben, Jr. (California Inst. of Tech., Pasadena). Astrophys. J., 138: 1090-6(Nov. 15, 1963).

The binding energy properties of quasistatic solutions to the equations of general relativity for star-like condensations of $10^2$ to $10^9$ solar masses are presented. With increasing central temperature and decreasing radius, the binding energy first increases through positive values, passes through a maximum, and then decreases rapidly to large negative values. The central temperature at which maximum binding occurs follows the rough law $T_c \sim 3.4 \times 10^{13}(M_\odot/M)$°K and the binding energy at this point is roughly $3.6 \times 10^{54}$ erg, nearly independent of mass. (auth)

**7379** COLLAPSE OF MASSIVE STARS. F. C. Michel (California Inst. of Tech., Pasadena). Astrophys. J., 138: 1097-1103(Nov. 15, 1963).

The conjecture of Hoyle and Fowler that massive stars are involved in the production of strong radio sources is examined. It is shown that the release of energy of the order of $3 \times 10^{61}$ ergs follows in a natural way from their model. Some corrections to the massive-star conjecture and the implication of these corrections to the expected energy release are discussed. (auth)

**7380** CONDUCTIVE HEATING OF THE SOLAR WIND. [PART] I. L. M. Noble and F. L. Scarf (Space Tech. Labs., Inc., Redondo Beach, Calif.). Astrophys. J., 138: 1169-81 (Nov. 15, 1963).

The hydrodynamic equations for the solar corona with no external heat source beyond a thin shell are solved for the case of fast expansion. The corona is assumed to be approximately 10 per cent ionized helium, and the Chapman value for the unihibited thermal conductivity can be used everywhere. The equations are integrated, from the earth to the sun, on an IBM 7090 computer, and a power series expansion is used in the neighborhood of the singularity at $r_c$, where $kT(r_c) = mu^2(r_c)$. It is found that thermal conduction naturally supplies sufficient heating to accelerate particles to the observed solar wind flux near the earth, if the inner coronal densities are near the accepted values, with a base temperature near $2 \times 10^6$°K. The stabilization effects associated with viscosity and the solar magnetic field are examined. (auth)

**7381** AMPLIFIED WHISTLERS AS THE SOURCE OF JUPITER'S SPORADIC DECAMETER RADIATION. David B. Chang (Univ. of California, La Jolla). Astrophys. J., 138: 1231-41(Nov. 15, 1963).

The generation and amplification of whistlers in a plasma with a nonisotropic relativistic component are studied by employing the relativistic collisionless Boltzmann equation to obtain the appropriate absorption coefficient, and using Einstein coefficient arguments to obtain the corresponding emissivity. It is found that whistler amplification may occur in plasmas with anisotropic velocity distributions under two quite different conditions: (a) $\omega_p^2 \gg \omega_c\omega \gg \omega^2$, and (b) $\omega \approx \omega_c$ and $\omega_p^2 \gg \omega_c\omega - \omega^2 > 0$. Here $\omega$, $\omega_c$, and $\omega_p$ are the whistler frequency, (nonrelativistic) electron gyrofrequency, and plasma frequency, respectively. Considerable amplification can occur in the presence of relativistic flat-helix electrons drifting in the direction of the wave. With the presence of relativistic flat-helix electrons in Jupiter's Van Allen belt required by the synchrotron radiation explanation of the continuous Jovian decimeter radiation, it is suggested that this amplification mechanism may be relevant to Warwick's dumping theory and Field's radiation belt theory of the origin of Jupiter's sporadic decameter radiation. (auth)

**7382** ON THE RELATION OF MAJOR SOLAR FLARES WITH CHANGES IN SUNSPOT AREAS. Robert Howard (Carnegie Institution of Washington, D. C. and California Inst. of Tech., Pasadena). Astrophys. J., 138: 1312-13(Nov. 15, 1963).

Observations of penumbral areas of sunspot groups and their change with cosmic-ray events are discussed. (R.E.U.)

**7383** WANTED: SOLAR-FLARE PREDICTORS. Joel A. Strasser. Electronics, 37: No. 2, 40-3(Jan. 10, 1964).

The present status of solar flare predictions and some programs of research into solar flares are discussed. A solar flare alarm system is described. (R.E.U.)

**7384** ON THE POSSIBLE PHASE STATES OF MATTER AT EXTREMELY HIGH DENSITIES. G. S. Sahaklan (Erivan State Univ.) and Yu. L. Vartanian. Nuovo Cimento (10), 30: 82-104(Oct. 1, 1963).

A study of the state of matter at extremely high densities and at absolute zero is given. In order to embrace all possibilities of the state of matter a hypothetical celestial body in the center of which the density is infinitely great, is treated. In the central sphere of such a body matter consists of a baryon gas. The concentrations of the electrons are of some orders smaller than the concentrations of each of the baryon types. A gradual recession from the center under certain values of densities brings about the consecutive disappearance of the $\Xi^0$, $\Sigma^+$, $\Xi^-$, $\Sigma^0$, $\Lambda$, and $\Sigma^-$ hyperons, the last of which disappears at densities of nuclear order ($N \sim 2 \times 10^{38}$ cm$^{-3}$). A further recession from the center is followed by the phases npe, npeA, neA, and eA. Here n, p, e, A mean respectively neutron, proton, electron, and nucleus. In the initial stage of the formation of atomic nuclei A and A/Z are anomalously great. As the density is reduced these magnitudes tend to their ordinary values. In the phase neA concentrations of electrons and nuclei and the parameters of the nuclei, A and Z, are fixed. In a certain layer of the star at the threshold of the npe phase formation $\mu^-$-mesons also occur. At densities $\rho \geq 1.5 \times 10^{13}$ g cm$^{-3}$ the state of matter differs considerably from that of the ideal gas. An equation of state is derived for that region with due consideration of the energy interaction among the baryons. (auth)

**7385** ON A POSSIBLE MEANING OF THE COSMIC CONSTANT IN AN EINSTEIN-DE SITTER UNIVERSE. F. M. Gomide (Università, Bologna). Nuovo Cimento (10), 30: 672-3(Oct. 16, 1963).

A cosmological constant is shown to be necessary if $10^{-31}$ g/cm$^3$ is to be accepted as the density of the Universe. The constant is proposed as $\Lambda = \frac{1}{3}(G^2M_p^4/C^2r^2\hbar^2)$ where r is the proton Compton wavelength and $GM_p^2/C^2r$ is the gravitational self-energy of the proton. The cosmic constant represents an unknown physical process and consequently the red-shift law for an empty Universe. (R.E.U.)

**7386** EVOLUTION OF STARS OF SMALL MASSES IN THE PRE-MAIN-SEQUENCE STAGES. Chushiro Hayashi and Takenori Nakano (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 30: 460-74(Oct. 1963).

The structure of the outer envelope with an H-ionization zone and an $H_2$-dissociation zone is investigated for Population I stars of small masses ($2M_\odot \geq M \geq 0.05M_\odot$), which have low luminosities ($L_\odot \geq L \geq 10^{-3}L_\odot$) and low effective temperatures (6000°K $\geq T_e \geq$ 2500°K), in order to find the surface condition for the internal structure of these stars. The effective temperature of a star that is wholly convective and that has an $H_2$-dissociation zone is found to be nearly constant in the wide range of its luminosity. Using stellar models composed of a radiative core and a convective envelope together with the above surface condition, the evolution of contracting stars is calculated up to the onset of hydrogen burning, and the results are compared with the observed red dwarf stars. It is found that the stars on the zero-age main-sequence have radiative cores for $M > 0.26M_\odot$ but they are wholly convective for $0.26M_\odot \geq M \geq 0.08M_\odot$. The stars less massive than $0.08M_\odot$ are found to contract toward the configurations of high electron-degeneracy without hydrogen burning. (auth)

**7387** THE EFFECT OF MAGNETIC FIELD ON THE DAMPING OF SHOCK WAVES. Mamoru Saitô and Shirô Sakashita (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 30: 571-3(Oct. 1963).

Magnetic field damping effects on the dissipation of hydromagnetic shock waves are investigated in connection with the heating of the galactic halo and the solar corona. It is concluded that the magnetic field reduces the dissipation only to about three-quarters of the dissipation without fields. (C.E.S.)

**7388** EVIDENCE FOR THE OCCURRENCE OF VIOLENT EVENTS IN THE NUCLEI OF GALAXIES. G. R. Burbidge (Univ. of California, La Jolla), E. M. Burbidge, and A. R. Sandage. Rev. Mod. Phys., 35: 947-72(Oct. 1963).

A number of phenomena, all associated with the nuclei of galaxies, which may suggest that in these nuclei there may take place violent events manifested by a very large energy output and a time scale as short as $10^6$ years, are investigated. Optical and radio data that lead to these conclusions are analyzed. (C.E.S.)

**7389** RECENT ADVANCES IN SCIENCE. ASTRONOMY. THE MAGNETIC FIELD OF THE GALAXY. PART II. D. McNally (London Univ.). Sci. Progr. (London), 51: 239-49(Apr. 1963).

The origin of galactic magnetic fields and theoretical studies on them are discussed. The works of various astronomers are presented. The properties of the tenuous intergalactic gas are considered because of their important bearing on the structure and evolution of galaxies. (R.E.U.)

**7390** EMISSION OF GAS FROM THE SUN. C. DeJager (Univ. of Utrecht). p.491-517 of "Space Research. III." New York, Interscience Publishers, 1963.

The solar corona, with its temperature of about $10^6$ °K, its low density, and its local variable magnetic field, is the source of the greater part of the interplanetary gas. The energy spectrum of these particles is very broad and extends up to about $10^{10}$ electron volts. Theories on the mass loss of the quiet sun are reviewed. From the activity centers with their greater magnetic fields, greater densities, and perhaps higher temperatures an enhanced steady flow may be expected. This quasi-static component may be especially observable during the declining phase of solar activity. Rapidly changing conditions in the solar activity centers lead to phenomena optically known as solar flares; these are connected with the emission of fast particles with velocities ranging from some tens of kilometers to that of light. A well-known flare-associated phenomenon is the production of relativistic particles. A review is given of observations and proposed mechanisms. (auth)

**7391** DIRECT OBSERVATIONS OF SOLAR PLASMA STREAMS AT A DISTANCE OF ~1,900,000 km FROM THE EARTH ON FEBRUARY 17, 1961, AND SIMULTANEOUS OBSERVATIONS OF THE GEOMAGNETIC FIELD. K. I. Gringauz, V. V. Bezrukikh, S. M. Balandina, V. D. Ozerov, and R. E. Rybchinskii. p.602-7 of "Space Research. III." New York, Interscience Publishers, 1963.

Final results from the processing of the data of the experiment aimed at investigating solar plasma streams from the Venus probe launched on February 12, 1961, are

presented. The results are compared with the geomagnetic field simultaneous observations. (auth)

**7392** PROPAGATION OF SOLAR PARTICLES DEDUCED FROM MEASUREMENTS WITH EXPLORER VII. S. Yoshida (Nagoya Univ., Japan), K. Nagashima, K. Kawabata, and M. Morimoto. p.609-18 of "Space Research. III." New York, Interscience Publishers, 1963.

Solar sub-cosmic-ray events were observed with Explorer VII. Analysis of the events gives the following results on a relation with solar events and a propagation of sub-cosmic particles through interplanetary space. 17 out of 23 events are found to have a one-to-one correspondence with solar radio burst of meter type IV. Remaining 6 events are not associated with any observed solar activity and are supposed to be caused by solar activities on the invisible hemisphere of the sun. Intentisy-time curves can be explained by a 3-dimensional diffusion of particles. An injection time of particles from a source into interplanetary space derived from an analysis of the above curve is on an average several hours after the starting time of the associated flare. The diffusion appears to start at position 0.2–0.3 AU from the sun. (auth)

**7393** CORPUSCULAR SOLAR STREAMS WITH FORCE-FREE MAGNETIC FIELDS. E. I. Mogilevskii (Inst. of Terrestrial Magnetism, Ionosphere and r.w. Propagation, Moscow). p.619-23 of "Space Research. III." New York, Interscience Publishers, 1963.

An attempt was made to find out some main properties and the structure of a corpuscular stream from the observational data and the analysis of plasma movements in active regions of the sun with a bipolar magnetic field. The magnetic field of such a stream, whose energy exceeds the kinetic energy of the stream, is not a magnetic frozen field in a stream plasma, but a force-free field of a closed current system of the stream plasma. The stability of such a stream and main features of interaction of it with the magnetosphere and ionosphere of the earth are determined essentially not by a stream plasma, but by a direct influence of a force-free magnetic field of the stream. (auth)

**7394** SOME PROBLEMS IN THE PHYSICS OF THE INTERPLANETARY MEDIUM. J. C. Brandt (Univ. of California, Berkeley). p.644-8 of "Space Research. III." New York, Interscience Publishers, 1963.

A model of the interplanetary medium based on empirical evidence is described. On the basis of this model, three interesting physical problems are discussed; the problem of the origin of the interplanetary medium, the velocity distribution and the velocity anisotropy, and the suspected stopping of the solar wind near 2 AU. See also NSA 17: 5165. (auth)

**7395** IONS OF THE Li I SEQUENCE IN THE SOLAR ULTRA-VIOLET SPECTRUM. Charlotte Pecker (Institut d'Astrophysique, Paris). p.809-13 of "Space Research. III." New York, Interscience Publishers, 1963.

In the solar rocket ultraviolet spectrum, many resonance and subordinate lines were observed coming from ions of the Li I sequence. Ionization potentials range from 64.5 ev for C IV to 523.2 ev for Si XII. Thus C IV is probably formed in the same region as He II, which begins to be observed at about 1500 km, while Si XII is probably formed in the same region as the visual coronal lines, beginning near 5,000 km. Study of this Li I sequence should permit mapping of this region of the outer solar atmosphere. Some of the resonance lines (e.g., C IV, N V, O VI) can be optically thick; so radiation transfer problems must be included in an interpretation of the observed lines to obtain, e.g.: height-distribution of emitting ions; thus whether they are formed in regions of rapid rise in $T_e$ or quasi-isothermal regions. A preliminary study of the excitation mechanisms and their relation to opacity effects was made. (auth)

**7396** PRELIMINARY SOLAR FLARE OBSERVATIONS WITH A SOFT X-RAY SPECTROMETER ON THE ORBITING SOLAR OBSERVATORY. W. E. Behring, W. M. Neupert, and J. C. Lindsay (NASA Goddard Space Flight Center, Greenbelt, Md.). p.814-21 of "Space Research. III." New York, Interscience Publishers, 1963.

A spectrometer carried by the Orbiting Solar Observatory and used for observing the solar spectrum from 10 to 400 Å is described. The instrument utilizes a concave-grating mounted in grazing-incidence and an open-window photomultiplier. Resolution of approximately 1 Å is obtained throughout the wavelength region covered. Solar spectra obtained with this instrument during a rocket flight are shown and tentative identifications of the origins of the observed spectral lines are listed. Preliminary satellite results obtained during solar flares are discussed. (auth)

**7397** A NOTE ON BURSTS OF RADIO EMISSION AND HIGH ENERGY (>20 kev) X-RAYS FROM SOLAR FLARES. C. De Jager (Sterrewacht "Sonnenborgh," Utrecht) and M. R. Kundu. p.836-8 of "Space Research. III." New York, Interscience Publishers, 1963.

The strong correlation between x-ray bursts of the sun and microwave radiobursts is discussed. When x-ray bursts and type III radiobursts are observed simultaneously, these two phenomena are most probably due to different jets of electrons, accelerated in different directions. (auth)

**7398** INVESTIGATIONS OF SOLAR X-RAYS AND LYMAN ALPHA RADIATION ON AUGUST 19-20, 1960. A. I. Efremov, A. L. Podmoshenskii, O. N. Efimov, and A. A. Lebedev. p.843-54 of "Space Research. III." New York, Interscience Publishers, 1963.

A radiation detector consisting of an open-type secondary-emission multiplier together with various filters automatically moved in front of the window was mounted aboard spaceship II. It was found that radiation in the region 44 to 100 Å was always constant within an accuracy of 88%. The radiation flux in the region 8 to 21 Å was constant most of the time, but during flares an increase was observed of 63% at one time and of 3.2 times during another flare. In the region below 8 Å, the quiet sun's radiation was very insignificant, but increased sharply (by more than a factor 11) during the flare on August 19, 1960, at 15 hours, 40 minutes, Moscow time. In the region 1.4 to 3 Å, only a background due to radiation of a nonsolar origin was recorded. The radiation of the quiet sun was identified with a corona temperature $T = 0.9 \times 10^6$ °K, and during the flare, with a temperature of $6.5 \times 10^6$ °K. The spectral distribution of the short-wave solar radiation flux over the earth's atmosphere is determined. Lyman-alpha emission at 1216 Å yields a flux of 5 to 6 erg $cm^{-2}$ $sec^{-1}$. It was not constant, but did not increase during the flare at 15 hours 40 min on August 19, 1960. (auth)

**7399** ALBEDO RADIATION FROM THE MOON AND THE PLANETS. Satio Hayakawa (Nagoya Univ., Japan). p.984-8 of "Space Research. III." New York, Interscience Publishers, 1963.

Nuclear radiations induced by cosmic rays on the solid surface of the moon or the planets are considered. Following the discussions on the significance of their observations, the intensities and the energy spectra of various components and their dependences on the chemical composition are calculated in a semiquantitative way. The com-

ponents concerned are protons and $\alpha$-particles knocked-out from nuclei by nuclear active particles of cosmic rays, $\gamma$-rays associated with the evaporation of nuclei as well as with the capture of neutrons, high energy $\gamma$-rays as decay products of neutral pions, and high energy electrons due to muon decays. (auth)

**7400** LUNAR LUMINESCENCE AND SOLAR RADIATION. J. F. Grainger and J. Ring (Univ. of Manchester, Eng.). p.989-96 of "Space Research. III." New York, Interscience Publishers, 1963.

Early observations of lunar luminescence are referred to, and the method adopted for its detailed investigation is described. A spectrometer was designed and built for this purpose, and first observations were made on the H-Fraunhofer line. Luminescence was detected, and in the course of the investigations it emerged that daytime sky-light also contains a component that is not directly scattered sunlight. Observations to support this statement are given, together with a brief discussion of the possible mechanisms involved. The energy requirements of the observed lunar luminescence are considered, and the possibility of its stimulation by either electromagnetic or corpuscular radiation from the sun is discussed. (auth)

**7401** INTRODUCTORY REVIEW ON THE RADIO EMISSION OF THE PLANETS. Cornell H. Mayer (Naval Research Lab., Washington, D. C.). p.1006-14 of "Space Research. III." New York, Interscience Publishers, 1963.

The results of the observations of planetary r-f radiation made over the last seven years are reviewed. Some of the general conclusions inferred from the observations are now well known, for example, that the centimeter radiation from Venus suggests a very high surface temperature and that the decimeter radiation of Jupiter suggests extensive radiation belts around the planet. The evidence for these and other less well known results is briefly summarized. (auth)

**7402** THE RESULTS OF THE VENUS RADIO ASTRONOMICAL OBSERVATIONS CARRIED OUT AT THE P. N. LEBEDEV PHYSICAL INSTITUTE. A. D. Kuzmin and A. E. Salomonovich (P. N. Lebedev Physical Inst., Moscow). p.1015-21 of "Space Research. III." New York, Interscience Publishers, 1963.

Observations with a 22-m radiotelescope beginning at 0.8 cm at the time of the 1959 inferior conjunction of Venus revealed a phase variation of the brightness temperature. This variation indicates a difference in brightness temperatures between the illuminated and nonilluminated hemispheres. The value of the brightness temperature (315 ± 70 °K) is lower than that measured at 3 and 10 cm. This was interpreted as a result of absorption in the colder planetary atmosphere. During a period before the 1961 inferior conjunction, observations were continued at 0.4, 0.8, 3.3, and 9.6 cm. At the first two wavelengths, a tendency toward a regular rise in the brightness temperature accompanied by an increase in the relative area of the illuminated portion of the disk (K) was detected. The minimum temperatures obtained at 0.4 and 0.8 cm are 390 ± 120 and 374 ± 75 °K, respectively. At 3.3 cm, the measurements were made in a phase range of K = 0.33 to K = 0.6. The average brightness temperature in this range was equal to 542 ± 85 °K. The mean value of the brightness temperature measured at 9.6 cm is 690 °K. The brightness temperature of the illuminated hemisphere is estimated not to exceed 800 °K. The existence of a component is suggested which possibly arises from ionospheric radiation on Venus. (auth)

# Atomic Physics

**7403** (BNL-7414) INELASTIC NEUTRON SCATTERING BY LIQUIDS. H. Palevsky (Brookhaven National Lab., Upton, N. Y.). Oct. 3, 1963. Contract AT-30-2-GEN-16. 39p. (CONF-366-1)

From General Motors Symposium on Liquids, Structures, Properties, and Solid Interactions, Warren, Mich., Sept. 1963.

The inelastic scattering of low energy neutrons from condensed matter offers a means of investigating the motions of atoms in liquids or solids down to times in the order of $10^{-12}$ to $10^{-13}$ seconds. The theoretical framework and techniques of such measurements are discussed, and the results of cold neutron measurements with liquid $H_2O$ and Pb are presented. In $H_2O$ the data show that for times in the order of $10^{-12}$ seconds the water molecule tends to maintain some average position with respect to its neighbors. In this sense, the short time behavior of water is similar to that of a solid. Diffusion characteristic of a liquid occurs at later times. Measurements in liquid lead just above the melting point also show the same effect but not as markedly. (auth)

**7404** (NP-13430) SPUTTERING YIELDS. Annual Report, November 1, 1962 to October 31, 1963. R. V. Stuart and G. K. Wehner (General Mills, Inc., Minneapolis). Nov. 1963. Contract Nonr 1589(15). 62p.

Energy distributions are determined for atoms sputtered from Cu (100), (110), and (111) surfaces as well as polycrystalline surfaces of about ten different target materials under Hg and noble gas ion bombardment in the range 80 to 1200 ev. Energies of sputtered atoms are found to depend markedly on the angle of ejection and the mass of the incident ion. The most probable energy (the energy at which the maximum occurs) is nearly independent of bombarding ion energy down to about 100 ev. At increasing bombarding ion energy the high energy tail in the energy distribution becomes more pronounced and causes the average energy to increase. Finally, an asymptotic value is reached at about 1000 ev bombarding ion energy. For Au-$Ar^+$ the energy distribution at 1200 ev bombarding ion energy is fairly similar to that at 43 kev with the average energies of 18.5 and 20.5 ev, respectively. (auth)

**7405** (TID-19923) THE IONIZATION OF ALKALI IONS BY ELECTRON IMPACT. Quarterly Technical Progress Report No. 4 (Annual Summary Report), September 1, 1963 to November 30, 1963. J. W. Hooper, E. W. McDaniel, and W. C. Lineberger (Georgia Inst. of Tech., Atlanta. School of Electrical Engineering). Dec. 1, 1963. Contract AT(40-1)-3027. 6p.

Research activities on the measurement of the cross section for ionization of lithium ions by electron impact over an electron energy range extending from threshold (75.6 ev) to 1000 ev are discussed. Information is provided on the development of an ultrahigh vacuum facility in which to conduct the final experiments; the study of electron sources capable of producing rectangular beams of high current density and predictable spatial distribution; and the development of a thermionic source and beam analyzing system. (N.W.R.)

**7406** (TID-19932) STUDIES OF $H_2^+$ DISSOCIATION. A. W. Ehler (Hughes Aircraft Co. Hughes Research Labs., Malibu, Calif.). Jan. 2, 1964. Contract AT(04-3)-362. 17p.

When the electric field dissociation fraction is measured

by taking the ratio of the $H^+$ ion current in the complete energy spectrum to the total $H_2^+$ ion current reflected from the dissociation chamber, the fraction is several times greater than that indicated by the data of Sweetman. Additional checks were made which ascertain that the dissociation fractions presented are representative of electric field dissociations only. (auth)

**7407** (UCRL-10904) MUTUAL CHARGE NEUTRALIZATION OF GASEOUS IONS (thesis). James Carl Person (California. Univ., Berkeley. Lawrence Radiation Lab.). July 11, 1963. Contract W-7405-eng-48. 147p.

The problem of the bimolecular rate constant, $\alpha$, for the mutual charge neutralization reaction (ion-ion recombination) for ions formed by the vacuum ultraviolet photolysis of nitric oxide is considered. The pressure dependence of $\alpha$ over a pressure range of 10 to 600 torr for mixtures of a few hundred microns of NO with He, Ar, Kr, Xe, $H_2$, $D_2$, and $N_2$ was measured. From the low-pressure limit of $\alpha$, the rate constant for charge neutralization in the absence of a third body was found to be $k_0 = 2.1 \pm 0.4 \times 10^{-7}$ cm$^3$/sec. The high-pressure limit of $\alpha$ was estimated to be $2.0 \pm 0.5 \times 10^{-6}$ cm$^3$/sec. The third-body efficiencies for promoting the charge-neutralization reaction were measured. The results, relative to He as the third-body gas, are $H_2 = 1.4 \pm 0.4$, $D_2 = 1.5 \pm 0.4$, Ar = 3.6 ± 0.8, Kr = 4.3 ± 1.0, $N_2 = 5.2 \pm 1.1$, and Xe = 6.8 ± 1.5. The average ionic mobility in the gas mixtures is estimated, and the mobilities indicate that at least some of the ions must be present as ion clusters. It is shown that the addition of $NO_2$ or $H_2O$ further lowers the mobility. A detailed calculation of the three-body charge-neutralization process was made using a computer. This calculation considers that the rate of charge neutralization is the rate at which ion pairs are deactivated by collision with the neutral gas molecules to form ion pairs that cannot separate to large distances. The potential between the ions and the neutrals is assumed to be an ion-induced dipole potential with a hard-sphere core. The calculation involves an average over the various angles in the collisions. The predicted values of $\alpha$ depend on a parameter of the calculation, but over a wide range of this parameter the predicted relative third-body efficiencies are in reasonable agreement with the experimental values. (auth)

**7408** ON THE PRESSURE-DEPENDENCE OF SOME PARAMETERS OF A. C. DISCHARGES. J. Bitó (Industrial Research Inst. for Telecommunication Technique, Budapest). Acta Phys. Acad. Sci. Hung., 16: 275-88 (1963).

The probe measurement method based on the pulse technique introduction by Waymouth and its application to the examination of discharges operated by a supply voltage of 50 c are described. In this connection the pressure-dependence of some characteristic parameters is examined; the dependence of the cathode-fall, the axial field strength, the plasma potentials, and the pressure of the applied argon ground gas, is shown for a mercury vapor discharge. The results obtained are discussed and compared with the data appearing in recent literature. (auth)

**7409** COMPUTER EXPERIMENTS ON ION-BEAM NEUTRALIZATION WITH INITIALLY COLD ELECTRONS. D. A. Dunn and I. T. Ho (Stanford Univ., Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 2770-7(Dec. 1963).

Trajectories of electrons and ions shot into an initially field-free space, as in the ion-propulsion problem, were obtained using a one-dimensional model. The results of a set of computer experiments are presented, in which the ratios of electron-to-ion injection velocities and currents are varied for large but finite ratios of ion-to-electron mass. For electron-to-ion velocity ratios less than about 2, static theories of neutralization are confirmed. For unneutralized and partially neutralized beams, oscillations, and in some cases, randomization of electron trajectories are observed. For electron-to-ion velocity ratios greater than 2 and electron-to-ion current ratios greater than a critical value, neutralization is obtained by means of an oscillating electron sheath that feeds electron current to the ion beam in a self-compensating manner. (auth)

**7410** DECAY OF A MAGNETOHYDRODYNAMIC SHOCK WAVE PRODUCED BY A PISTON. Roy M. Gundersen (Univ. of Wisconsin-Milwaukee, Milwaukee). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 2844-5(Dec. 1963).

The interaction of a uniform shock wave and a centered rarefaction wave in the one-dimensional, unsteady flow of an ideal, inviscid, perfectly conducting, monatomic, compressible fluid subjected to a transverse magnetic field is discussed. A uniform shock wave is generated by pushing a piston with constant velocity into a tube filled with gas at rest. The piston is stopped abruptly thus generating a centered rarefaction wave, which propagates with true-sonic speed and ultimately overtakes the shock and diminishes its strength. Under the assumption that the shock wave is weak or at most of moderate strength, the width of the interaction zone and the subsequent motion of the shock wave may be determined by an extension of the Friedrichs' theory for conventional gasdynamic flow. For a monatomic fluid, generalized Riemann invariants and the flow parameters in a centered simple wave may be determined explicitly. (C.E.S.)

**7411** THE HYDROMAGNETIC INSTABILITY OF AN INFINITELY LONG SELF-GRAVITATING INCOMPRESSIBLE PLASMA CYLINDER. Y. K. Verma and Pratibha Verna (Delhi Univ.). Appl. Sci. Res., Sect. B, 10: 216-30 (1963).

An infinitely long self-gravitating incompressible plasma cylinder is considered. Inside the cylinder there is a uniform magnetic field $B_i$ parallel to its axis and outside there are magnetic fields $B_e$ parallel to the axis and $B_0 r_0/r$ in the azimuthal direction. The surface currents arising due to the discontinuity in the magnetic fields across the surface are incorporated into the boundary conditions to derive a dispersion relation. The conclusions are: (a) The magnetic field configuration ($B_i = B_e = B_0$) has got a stabilizing effect for modes m = 0, 1, and 2, for modes m = 1 and 2 it keeps the cylinder always stable. (b) The $B_i$ field is more effective than the $B_e$ field in stabilizing the cylinder for mode m = 0 and m = 1. For mode m = 2, $B_e$ becomes more effective than $B_i$. (c) The effect of $B_0$ field is to destabilize shortwave perturbations for m = 0, to destabilize any given perturbation for m = 1 when $B_0^2 > 8\pi^2\rho^2 r_0^2 G$; but for mode m = 2 it stabilizes very large waves as well as shortwave perturbations, while it destabilizes very short wave perturbations. (auth)

**7412** WAVE FUNCTIONS AND OSCILLATOR STRENGTHS FOR THE LITHIUM ISOELECTRONIC SEQUENCE. Andrew W. Weiss (National Bureau of Standards, Washington, D. C.). Astrophys. J., 138: 1262-76(Nov. 15, 1963).

Hartree-Fock wave functions for the $1s^22s$, $1s^22p$, $1s^23s$, $1s^23p$, and $1s^23d$ configurations of the lithium-isoelectronic sequence through Z = 10 were calculated. Oscillator strengths for all possible transitions between these levels

were computed utilizing the dipole length, velocity, and acceleration forms of the transition matrix element. In addition, the 2s-2p transition was calculated using a 45-term configuration interaction function for both states. (auth)

**7413** UPPER AND LOWER BOUNDS FOR GROUND-STATE SECOND-ORDER PERTURBATION ENERGY. Stephen Prager (Univ. of Minnesota, Minneapolis) and Joseph O. Hirschfelder. J. Chem. Phys., 39: 3289-94 (Dec. 15, 1963).

The first-order perturbation equation, using the Dalgarno-Lewis formulation, is arranged in a form analogous to the Poisson equation for the electrostatic potential produced by a charge distribution in a medium of variable dielectric constant. Thus, the Thomson and Dirichlet variational principles of electrostatics can be used to obtain approximate solutions to the first-order perturbation equation for systems in either the ground state or the lowest energy state of a given symmetry. The Thomson principle provides a useful lower bound to the second-order perturbation energy. The Dirichlet principle is derivable from the Rayleigh-Ritz or Hylleraas principles and gives an upper bound to the second-order energy. For excited states, the Sinanoğlu principle provides the upper bound. By optimizing the scaling of the trial perturbed wavefunction, the Hylleraas principle is presented in a somewhat improved form. As an example, the polarizability of atomic hydrogen is used to illustrate both the Thomson and Dirichlet principles and to place upper and lower bounds on the polarizability. (auth)

**7414** POTENTIAL-ENERGY CURVE OF THE LOWEST-LYING TRIPLET SIGMA STATE OF LITHIUM HYDRIDE. Howard S. Taylor (Univ. of Southern California, Los Angeles and Jet Propulsion Lab., Pasadena, Calif.). J. Chem. Phys., 39: 3382-91(Dec. 15, 1963).

The potential-energy curve of the lowest-lying triplet sigma state of lithium hydride was computed by a variational technique. Linear combinations of products of two-center molecular orbitals were used to approximate the wavefunction. All linear and nonlinear parameters are minimized and open-shell techniques are utilized. The triplet state is shown to be of a repulsive nature. (auth)

**7415** GENERALIZED MASTER EQUATIONS FOR THE DENSITY MATRIX. Robert L. Peterson and Paul M. Quay (Case Inst. of Tech., Cleveland). J. Math. Phys. (N. Y.), 5: 85-9(Jan. 1964).

Generalized master equations determining the time dependence of both diagonal and off-diagonal density matrix elements are derived. The equations are valid for systems of arbitrary size and initial conditions, and have all the generality of the von Neumann equation for the density matrix. They are general enough for use in determining all higher-order contributions to transport coefficients. Their advantage over the von Neumann equation is that they are in forms suited to reduction by time-independent many-body approximation techniques. (auth)

**7416** EXCITATION SPECTRUM OF AN IMPURITY IN THE HARD-SPHERE BOSE GAS. Toshio Soda (Univ. of Chicago). J. Math. Phys. (N. Y.), 5: 142-6(Jan. 1964).

The impurity excitation spectrum is calculated for the hard-sphere Bose gas with dilute impurity concentration, using the pseudopotential method of Lee, Huang, and Yang. The spectrum for the ideal case, in which the mass and interaction of impurity are the same with those of the bosons in the gas, is $k^2$ in the unit of $2m_a = \hbar = 1$ ($m_a$ being the mass of boson, and k the momentum of impurity), with an effective mass correction of $-{}^{64}/_{45}[(\rho a^3)^{1/2}/\pi^{1/2}]k^2 + O[(\rho a^3)k^2, k^4]$, where $\rho$ is the density of the boson gas, and a is the hard-sphere diameter of the boson. The general impurity case is also calculated and found to have an impurity spectrum $rk^2$, with a similar effective mass correction, where r is the mass ratio of the boson to the impurity. (auth)

**7417** AN INTENSE MAGNETRON ION SOURCE FOR HIGH-MELTING POINT MATERIALS. B. Čobić, D. Tošić, and B. Perović (Inst. of Nuclear Sciences, Belgrad). Nucl. Instr. Methods, 24: 358-64(Oct. 1963).

The characteristics of the magnetron-type gas discharge as an intense ion source were investigated. The ion source was applied to the electromagnetic mass separator. The intensity of the anode current was measured as a function of the parameters $I_f$, $V_a$, $H_z$, p. The optimal conditions for obtaining intense ion beams were investigated especially in the region of the anode current cut-off. Taking advantage of the ion source geometry, a new method for obtaining intense ion beams of high temperature materials was developed. By this method the ion beams of Ti, Fe, Ni, Mo, La, Ce, Nd, W, Ir, were produced. The charge materials used were in elementary or oxide form. (auth)

**7418** POSITRONIUM DECAY IN THE ICE-WATER SYSTEM. G. Fabri (Laboratori C.I.S.E., Milan), E. Germagnoli, I. F. Quercia, and E. Turrisi. Nuovo Cimento (10), 30: 21-7(Oct. 1, 1963).

The decay features of positrons in the ice-water system are described, as they result from life-time measurements and magnetic quenching experiments. The anomalous behavior of the $\tau_2$ component results from a number of experimental facts and makes doubtful that the events involving the long life-time are associated with the decay of the free positronium atom. (auth)

**7419** PERTURBATION METHOD FOR DIATOMIC MOLECULES. E. Corinaldesi (Instituto Nazionale di Fisica Nucleare, Pisa, Italy and Università, Pisa, Italy). Nuovo Cimento (10), 30: 105-11(Oct. 1, 1963).

The homopolar binding of diatomic molecules is treated by a method employing a modified Schrödinger equation for a multi-component wave function. (auth)

**7420** WEAK-COUPLING VERSION OF BOGOLIUBOV'S KINETIC THEORY OF GASES. J. Stecki (Univ. of Southern California, Los Angeles). Phys. Fluids, 7: 33-7 (Jan. 1964).

The version of Bogoliubov's theory of irreversible phenomena in gases, in which the coupling constant is used as an expansion parameter, is generalized to all orders. (auth)

**7421** MANY-BODY FUNCTIONS OF A ONE-DIMENSIONAL GAS. R. J. Baxter (Australian National Univ., Canberra). Phys. Fluids, 7: 38-43(Jan. 1964).

Formal expressions are obtained for the thermodynamic behavior and many-body functions of a one-dimensional system of particles with an arbitrary interaction potential. These expressions are particularly simple when the potential function satifies a linear differential equation with constant coefficients over the domain $(0, \infty)$. Explicit, exact results are obtained for a Coulomb interaction and compared with the Kirkwood approximation. (auth)

**7422** MAGNETOHYDRODYNAMIC SHOCK WAVES AND MAGNETICALLY DRIVEN SHOCK TUBES. W. H. Heiser (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 7: 143-5(Jan. 1964).

Experiments were carried out in an attempt to determine whether or not magnetohydrodynamic switch-on shocks can

be generated. Strong shock waves were produced in hydrogen by means of a magnetically driven shock tube of annular geometry. It is assumed that the absolute light intensity is proportional to the particle density squared and is virtually independent of the gas temperature. Results obtained at a wavelength of 3800 Å indicate that the switch-on shock was probably observed. (C.E.S.)

**7423** SHOCK TUBE STUDIES OF MAGNETICALLY INDUCED IONIZATION. Bert Zauderer (General Electric Co., King of Prussia, Penna.). Phys. Fluids, 7: 145-7(Jan. 1964).

Magnetically induced ionization was observed in a segmented electrode magnetohydrodynamic generator mounted in a shock tube. This ionization is caused by the induced Faraday and Hall electric fields, which under certain circumstances raise the electron temperature above the gas temperature resulting in nonthermal ionization. If the induced currents are large enough so that the Lorentz force exceeds the gas dynamic forces, compressional or shock heating of the gas occurs that raises the gas temperature resulting in thermal ionization. Results are reported for argon, krypton, and xenon. (C.E.S.)

**7424** COMPUTING THE AC CONDUCTIVITY OF A WEAKLY IONIZED MIXTURE OF GASES. Paul Molmud (Space Technology Labs., Redondo Beach, Calif.). Phys. Fluids, 7: 150-1(Jan. 1964).

It is shown that the basic integral for computing the a-c conductivity of a weakly ionized mixture of gases is reducible to tabulated functions if the collision frequency of electrons and gas molecules is representable by a finite series as a function of velocity. (C.E.S.)

**7425** ARGON K ABSORPTION EDGE BY THE COUNTER RESPONSE-METHOD. Herbert W. Schnopper (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 133: A627-8 (Feb. 3, 1964).

The fine structure of the argon K absorption edge was observed by measuring the response of an argon-filled proportional counter as a function of the incident x-ray energy. It is shown that the response of a thin counter is proportional to $\mu_K$, the K-shell contribution to the linear absorption coefficient. The fine structure observed in this method is then shown to be the same as is recorded in the conventional absorption method. (auth)

**7426** SHOCK-TUBE MEASUREMENT OF THE POLARIZABILITY OF ATOMIC HYDROGEN. Wayland C. Marlow (Lockheed Missiles and Space Co., Palo Alto, Calif.) and Daniel Bershader. Phys. Rev., 133: A629-32 (Feb. 3, 1964).

The electric polarizability of atomic hydrogen was measured at optical frequencies by shock heating a gaseous mixture of argon and molecular hydrogen to temperatures causing nearly complete dissociation of the latter. Application of Mach-Zehnder interferometry to the shock-heated gas gave measurements of fringe shift across the shock front that were subsequently reduced to obtain the polarizability of the ground state of atomic hydrogen. The resultant value is $\alpha_H = (4.61 \pm 0.07)a_0^3$, for a wavelength of 5870 Å, where $a_0$ is the first Bohr radius and the error assignment is purely statistical. The shock waves employed were in the Mach number range 10 to 12 in a $\frac{2}{3}$ Ar–$\frac{1}{3}$ $H_2$ mixture (by volume) and produced temperatures of the order of 4600°K at densities high enough to ensure thermal equilibrium. Under these conditions there was negligible ionization or excitation of the argon diluent. In contrast to earlier experiments this result is in good agreement with the predictions of the quantum-mechanical time-dependent perturbation theory that gives a value of $\alpha_H = (4.66 \pm 0.01)a_0^3$ for the same wavelength as that used in the experiment. (auth)

**7427** CORRELATION EFFECTS IN ATOMIC STRUCTURE USING THE RANDOM-PHASE APPROXIMATION. P. L. Altick and A. E. Glassgold (Univ. of California, Berkeley). Phys. Rev., 133: A632-46(Feb. 3, 1964). (TID-19537)

A procedure for treating correlations in atomic structure is introduced and applied to the calculation of excitation energies, oscillator strengths, and photoionization cross sections. The method is the extension of the Hartree-Fock theory known as the random-phase approximation, which was previously applied to a number of other many-body problems. In this application to atomic physics results are given for beryllium, magnesium, calcium, and strontium. These atoms all have $^1S$ ground states, and only $^1P$ states are considered. The general conclusion of the study is that the values of the oscillator strengths and photoionization cross sections are changed significantly by the correlations, while the changes in the values of the excitation energies are quite small. Wherever comparison with experiment is possible, the inclusion of these correlations improves the agreement between theory and experiment. Their effects are, however, not as marked as in highly degenerate infinite systems or in nuclei. (auth)

**7428** FARADAY ROTATION OF RARE-EARTH (III) PHOSPHATE GLASSES. S. B. Berger, C. B. Rubinstein, C. R. Kurkjian, and A. W. Treptow (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 133: A723-7(Feb. 3, 1964).

The optical Faraday rotation of trivalent rare-earth phosphate glasses was investigated at room temperature. The rotation is ascribed primarily to strong electric dipole transitions involving the rare-earth 4f electrons and is described as a function of the incident light wavelength by a simplified equation involving an effective transition wavelength. The linear dependence of the rotation on the concentration is experimentally demonstrated. The relative magnitudes of the magnetic rotation of the rare-earth ions are compared to the quantity $p^2/g$, where p is the effective magneton number and g is the spectroscopic splitting factor. This comparison demonstrates the importance of the other parameters, especially the transition wavelengths and electric dipole matrix elements. It also indicates that a prediction of relative rotations of ions, molecules, etc., on the basis of relative magnitudes of magnetic susceptibility and concentration alone is not meaningful. (auth)

**7429** BAND STRUCTURE AND FERMI SURFACE OF BERYLLIUM. T. L. Loucks and P. H. Cutler (Pennsylvania State Univ., University Park). Phys. Rev., 133: A819-29(Feb. 3, 1964).

Using a self-consistent potential, the energy eigenvalues along the symmetry edges, on the zone faces, and at the equivalent of 5184 general points in the first Brillouin zone were calculated for beryllium by expanding the conduction electron wave functions in a linear combination of 23 orthogonalized plane waves. From this the Fermi energy and density of states were calculated and the Fermi surface constructed. The density of states is in agreement with soft x-ray emission and absorption data and with the experimental low-temperature specific heat coefficient. The Fermi surface consists of three pieces: A region of unoccupied states in the first double zone which resembles a coronet, and two identical pockets of electrons in the second double zone similar in shape to a cigar with a tri-

angular cross section. The de Haas-van Alphen frequencies in 1/H predicted from the Fermi surface are in good agreement with those measured experimentally. (auth)

**7430** THE ATOMIC SPECTRUM OF NEODYMIUM. II. CLASSIFICATION OF LINES, ZEEMAN EFFECT AND ISOTOPE SHIFT OF Nd I. G. E. M. A. Hassan and P. F. A. Klinkenberg (Universiteit, Amsterdam). Physica, 29: 1133-54(Nov. 1963).

A detailed account is given of the classification of 555 Nd I lines in the spectrum of an electrodeless discharge. A comparison is made with the temperature classification known for 278 lines in the table. Zeeman effect measurements are reported for 110 classified lines observed in the spectrum of the hollow cathode operating in weak magnetic fields. From these splittings the g-factors of nearly 75% of all levels could be determined and the J-values could be checked so that only very few ambiguities remain. A discussion is given of the isotope shifts as measured by various authors in connection with the line classifications. Although configurations are far from pure, a definite correlation is established that will have to be taken into account when new identifications are made. (auth)

**7431** THEORY OF EXTENDED FINE STRUCTURE OF X-RAY ABSORPTION EDGES. Leonid V. Azároff (Illinois Inst. of Tech., Chicago). Rev. Mod. Phys., 35: 1012-22 (Oct. 1963).

The Kronig, Kostarev, Hayasi, and Sawadi theories of extended fine structure of x-ray absorption edges are discussed. The essential features of each theory and its success in interpreting experimental curves are outlined. The shortcomings of each theory are pointed out, and a general evaluation and comparison with experimental data are made. (C.E.S.)

**7432** DETERMINATION OF MOMENTUM TRANSFER AND INELASTIC COLLISION CROSS SECTIONS FOR ELECTRONS IN NITROGEN USING TRANSPORT COEFFICIENTS. A. G. Engelhardt, A. V. Phelps, and C. G. Risk. 16p. (CONF-364-5)

From 16th Annual Gaseous Electronics Conference, Pittsburgh, Oct. 1963.

A set of cross sections for momentum transfer and inelastic collisions for electrons in nitrogen, which are reasonably consistent with most of the available experimental data, are derived. The momentum transfer cross section differs but little from that of Frost and Phelps. The rotational cross sections used were derived from the theory of Gerjuoy and Stein. The positive polarization correction with a quadrupole moment of .96 $ea_0^2$ ($a_0$ is the first Bohr radius) is definitely superior to the negative polarization correction. The cross sections for vibrational excitation have the same shape as those measured by Schulz and are normalized to $5.5 \times 10^{-16}$ $cm^2$ at the peak occurring at 2.3 ev. In addition a tail below 1.7 ev was added to the v = 1 state. The thresholds of the six effective vibrational and electronic excitation cross sections are also consistent with the results of Schulz. Their shape and magnitude were determined to a large extent by comparison with experimental values of the excitation coefficient for the C state and the ionization coefficient. (auth)

**7433** HYDROGEN ION CROSS SECTION DETERMINATION BY ION CYCLOTRON RESONANCE. Darold C. Wobschall and John R. Graham, Jr. (Cornell Aeronautical Lab., Inc., Buffalo). 12p. (CONF-364-4)

From 16th Annual Gaseous Electronics Conference, Pittsburgh, Oct. 1963.

The collision cross sections of $H^+$, $H_2^+$, and $H_3^+$ in $H_2$ were determined from measurements of ion cyclotron resonance line widths. At low E/P, the $H_2^+ - H_2$ cross section was found to be $90(Å)^2$ and the $H^+$ cross section $150(Å)^2$, in agreement with theoretical estimates. The $H_3^+ - H_2$ cross section is $90(Å)^2$, in agreement with d-c mobility determinations. High E/P measurements were also made. From the ratio of line intensities, the cross section for the formation of $H_3^+$ from $H_2^+$ in $H_2$ was estimated to be of the order of $70(Å)^2$. These results confirm the generally held belief that $H_2^+$ cannot be observed with d-c mobility experiments. (auth)

## Cosmic Radiation

**7434** INTEGRAL SPECTRUM OF NUCLEAR ACTIVE PARTICLES AT MOUNTAIN ALTITUDES FROM THE INVESTIGATION OF HIGH IONIZATION PULSES. N. L. Grigorov (Univ. of Moscow), C. A. Tretyakova, V. J. Shestoperov, C. P. Babayan, N. G. Boyadsyan, J. Massalski, B. Niziol, and A. Oleś. Acta Phys. Polon., 24: 357-71 (Sept. 1963).

High ionization pulses were investigated with an apparatus of an area of 10 $m^2$ installed at mountain altitudes (3200 m above sea level) and containing 192 ionization chambers. The analysis of the results obtained showed a large part of the high ionization pulses to be caused by several nuclear active particles falling simultaneously on the apparatus. Nuclear active particles falling in groups cause the exponent of the integral spectrum of pulses registered on the area of 10 $m^2$ to be $1.33 \pm 0.03$ while the exponent of the spectrum due to individual nuclear active particles is $\geq 1.90 \pm 0.05$. (auth)

**7435** PROTON INTENSITIES AND ENERGY SPECTRUMS IN THE INNER VAN ALLEN BELT. W. L. Imhof and R. V. Smith (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Geophys. Res., 69: 91-100(Jan. 1, 1964).

Proton intensities and energy spectra in the inner Van Allen belt were measured with shielded plastic scintillators. Omnidirectional fluxes of protons above 59, 95, and 148 Mev are given at the equator for L values of 1.25 and 1.48–1.60, and isoflux contours are given in B, L space for protons above 59 Mev. The counting rates of three scintillation counters having threshold energies of 46, 76, and 128 Mev were analyzed in terms of assumed energy spectra of the form $d\phi/dE = AE^{-n}$ and $d\phi/dE = Ae^{-E/E_0}$. The second form produces a dependence on the geomagnetic parameter L given by $E_0 = 460L^{-4.6}$ Mev. For the theoretical spectral shapes of Lenchek and Singer, cutoff energies were derived from the ratios of counting rates in the three detectors. The results are in moderately good agreement with the calculations of Singer (in which, because of nonadiabatic effects, the cutoff momentum was found to be of the form $P_{max} = P_0L^{-2}$), with a best fit value $P_0 = 2000$ Mev/c. (auth)

**7436** TIME REVERSAL OF THE GEOCYCLOTRON MECHANISM. T. F. Bell (Stanford Electronics Labs., Calif.). J. Geophys. Res., 69: 177-9(Jan. 1, 1964).

A possible method of removing high-energy particles from natural or artificially produced radiation belts is outlined. The method is based on the idea of the geocyclotron and in essence is the time reversal of the geocyclotron mechanism. (C.E.S.)

**7437** ENERGY-DEPENDENCE OF THE POSITIVE EXCESS OF COSMIC-RAY $\mu$-MESONS. Y. Kamiya, H. Ueno, S. Sagisaka, and Y. Sekido (Nagoya Univ., Japan). Nuovo Cimento (10), 30: 1-4(Oct. 1, 1963).

The energy-dependence of the positive excess of cosmic rays was measured in the energy range 5 to 200 Bev using a magnetic spectrometer that consists of a solid-iron-core electromagnet and a neon hodoscope. The results are not inconsistent with the theory of Hayman in which it is assumed that there is an increase in the fluctuation of pion multiplicity with increasing primary energy. (auth)

**7438** DETERMINATION OF THE FLUX OF PRIMARY HYDROGEN AND HELIUM NUCLEI NEAR THE GEOMAGNETIC EQUATOR USING NUCLEAR EMULSIONS. I. PROTON FLUX, ON MARCH 12, 1960 AT GEOMAGNETIC LATITUDE 7.6° N. S. N. Ganguli, N. Kameswara Rao, and M. S. Swami (Tata Inst. of Fundamental Research, Bombay). Nuovo Cimento (10), 30: 33-9(Oct. 1, 1963).

Nuclear emulsions exposed to the cosmic radiation at geomagnetic latitude 7.6° N at an altitude of 31.3 km for six hours on March 12, 1960 were used to determine the primary cosmic proton flux. The flux at the top of the atmosphere is found to be (83 ± 12) protons $m^{-2}$ $sec^{-1}$ $sr^{-1}$. (auth)

**7439** THE APPARENT SIDEREAL DAILY VARIATION OF COSMIC-RAY INTENSITY AT 42 m w.e. UNDERGROUND AT HOBART, TASMANIA. I. RESULTS OF OBSERVATIONS IN 1958. R. M. Jacklyn (Dept. of External Affairs, Melbourne). Nuovo Cimento (10), 30: 40-76(Oct. 1, 1963).

The apparent sidereal daily variation of cosmic ray intensity underground at Hobart during 1958 is examined. There is a large annual mean apparent sidereal effect and a comparable anti-sidereal effect, associated with pronounced month by month changes in phase and amplitude of the solar daily variation. A technique is devised that permits the daily variation (d.v.) in sidereal time to be examined month by month, uncomplicated by the presence of certain background components, including for instance, a solar daily variation of constant phase and amplitude. An attempt is made to interpret the apparent sidereal effect on the assumption: a) that it is entirely spurious, arising from a solar-time modulation of the solar daily variation; b) that there is a genuine part to the effect, consisting of a sidereal d.v. of constant phase and amplitude, and a spurious part, arising from an annual variation of amplitude of the solar d.v., produced by a solar-time mechanism; c) that the effect is entirely genuine, arising from a sidereal-time modulated sidereal daily variation. The theory for each case is tested against the observations by means of models. When various simple possibilities are considered, it is found that the evidence clearly favors assumption c). The hypothesis that gives best agreement with the observations is that a solar d.v. of constant amplitude and phase is accompanied by a sidereal d.v. with semi-annual variation of amplitude and phase. In that case, the unmodulated sidereal d.v. would have amplitude 0.09% and RA ~0700 h, suggesting that the source of the anisotropy may be in the direction looking outward along the proposed spiral arm magnetic field. (auth)

**7440** ANISOTROPY OF $\mu$-RICH AIR SHOWERS. S. Sakakibara and Y. Sekido (Nagoya Univ., Japan). Phys. Rev., 133: B529-31(Jan. 27, 1964).

The data of $\mu$-meson rich air showers of cosmic rays were analyzed. The result showed that the arrival direction is nearly parallel to the Galactic arm, and the primaries are coming from the direction of the spiral-out of the arm. (auth)

**7441** COSMIC RAY OBSERVATIONS IN SPACE. D. A. Bryant, T. L. Cline, U. D. Desai, and F. B. McDonald (NASA Goddard Space Flight Center, Greenbelt, Md.). p.376-98 of "Space Research. III." New York, Interscience Publishers, 1963.

A full description of the cosmic-ray experiment on Explorer XII is given, and cosmic-ray measurements made during the solar event of September 28, 1961 are reported and discussed. Galactic cosmic-ray measurements are also reported. A few hours before the class-3 flare of September 28, two short counting rate increases were observed and are interpreted as electron bursts. The anisotropy of the medium-energy solar protons early in the event and the intensity of the medium- and low-energy solar protons throughout the event are described. It is found that the history of the intensity of the solar protons is consistent, once isotropy is established, with their having diffused through interplanetary space with an effective mean free path of 0.04 AU. This result is discussed and is shown to be not obviously in disagreement with the generally accepted views regarding the configuration of the interplanetary magnetic field. An estimate of the distance from the sun at which diffusion becomes unimportant and particles escape gives 2-3 AU. It is pointed out that simple diffusion, where the particles are scattered from discrete scattering centers and the influence of a general magnetic field is neglected, does not account for the direction of the anisotropy observed early in the event. Two days after the flare, and beginning just before the sudden commencement of a magnetic storm, there was a large increase in the intensity of protons between 2 and 15 Mev, the lower energy limit being determined by the sensitivity of the detectors. As most of these particles, which we have called "energetic storm particles," arrived after the sudden commencement occurred it is suggested that they were solar protons trapped within the plasma cloud that caused the magnetic storm. The outline of a possible trapping mechanism is given. Explorer XII measurements of the Forbush decrease of September 30, 1961 are compared with neutron monitor measurements at Deep River. The decrease is larger at Explorer XII by a factor of 1.7 ± 0.3. (auth)

**7442** ACCELERATION AND PROPAGATION OF FAST PARTICLES IN INTERPLANETARY SPACE. Juan G. Roederer (Univ. of Buenos Aires). p.518-28 of "Space Research. III." New York, Interscience Publishers, 1963.

The process of acceleration or modulation of galactic cosmic rays in interplanetary space and the propagation of solar-generated high-energy particles from the sun to the earth are discussed. Only the most outstanding features of experimental results are discussed, and connections with theoretical models for the structure of interplanetary magnetic fields are analyzed. (auth)

**7443** SOME NOTES ON LOW ENERGY SOLAR COSMIC RAYS AND INTERPLANETARY MAGNETIC FIELDS. Tatsuzo Obayashi (Kyoto Univ., Japan). p.624-9 of "Space Research. III." New York, Interscience Publishers, 1963.

The effect of interplanetary magnetic fields on cosmic-ray particles was investigated by the detailed comparison with results measured by the space probe, Pioneer V, and various solar-geophysical data obtained during March to April, 1960. It is shown that a plasma cloud ejected from the sun forms an expanding magnetic shell or bulge that is linked with the sun, and such a magnetic barrier can

trap or sweep out solar cosmic rays ejected from the flare, depending on the relative position of the injected particles and of the plasma cloud in space. (auth)

**7444** SOLAR PROTON INJECTIONS DURING THE PERIOD FROM JULY 12TH TO JULY 28TH, 1961 AT BALLOON ALTITUDES IN THE AURORAL ZONE (KIRUNA/SWEDEN). E. Keppler. A. Ehmert, and G. Pfotzer (Max-Planck-Institut für Aeronomie, Lindau, Ger.). p.676-87 of "Space Research. III." New York, Interscience Publishers, 1963.

Four cases of solar proton injection during July 1961 are reported after measurements over Kiruna/Sweden. Estimates on energy range, intensity, and intensity decay are given. In some cases nuclear gamma rays are found to be superimposed to the proton fluxes; their relations to variations of the geomagnetic field are investigated. (auth)

**7445** CLOUD CHANBER OBSERVATIONS OF GALACTIC AND SOLAR COSMIC RAY ELECTRONS. James A. Earl (Univ. of Minnesota, Minneapolis). p.688-91 of "Space Research. III." New York, Interscience Publishers, 1963.

A small but definite flux of galactic cosmic-ray electrons was detected on many occasions with balloon-borne multiplate cloud chambers. In particular, on May 12, 1960, the flux of galactic electrons of energy greater than 500 Mev was $(32 \pm 10)$ particles/$m^2$ sec sr or $(3 \pm 1)\%$ of the cosmic ray proton flux. Observations made on September 4, 1960, during a solar cosmic ray event showed no solar cosmic ray electrons and yielded an upper limit on the ratio of solar electron flux to solar proton flux of 0.25% for particles with momentum greater than 450 Mev/c. Measurements during June 1961 indicate that the electron flux is practically independent of depth in the range 5 to 10 $g/cm^2$. This shows that most of the electrons are primaries rather than secondaries produced in the air above the balloon. (auth)

**7446** SOLAR-PRODUCED HEAVY NUCLEI DURING NOVEMBER, 1960. Martin A. Pomerantz (Franklin Inst., Swarthmore, Penna.) and Louis Witten. p.692-9 of "Space Research. III." New York, Interscience Publishers, 1963.

The arrival of solar-produced heavy nuclei ($Z \geq 6$) was observed by equipment aboard Explorer VII (1959 Iota) in November, 1960. In six passes during the interval November 13-17 for which readable signals were recorded, solar-produced nuclei injected on November 12 and 15 were detected at high latitudes. Comparison of the measurements of multiply charged particles with Geiger counter data recorded simultaneously on the same tapes indicates that the magnetic rigidity spectra of the solar protons and heavy nuclei were similar. In the narrow range of latitudes for which the analysis can be performed, the integral flux varied as $R^{-8.5}$. The proton-heavy nucleus ratio remained the same except during the last pass, for which it was larger by a factor of 4. After each of the flares, the intensity of the solar heavy nuclei decayed with time, t, following onset as $t^{-3.1}$. (auth)

**7447** NEW DETERMINATION OF NEUTRON MONITOR COUPLING FUNCTIONS. R. J. Baduell, J. M. Cardoso, H. S. Ghielmetti, L. C. Marzulli, and J. G. Roederer (Facultad de Ciencias Exactas y Naturales and Comisión Nacional de Energia Atómica, Buenos Aires). p.700-8 of "Space Research. III." New York, Interscience Publishers, 1963.

Using new values for geomagnetic cutoff rigidities, the neutron monitor survey by Rose et al., was reanalyzed. A best-fit curve was derived, dividing the cutoff range into three intervals: 1 to 4 Bev, 4 to 11 Bev, and 11 to 15 Bev. The accurate determination of the coupling function in the first interval is important for the analysis of steep energy spectra of solar particles; the last interval determines the extrapolation to higher energies, which is important for flat spectra like those corresponding to Forbush decreases. Coupling functions for sea level neutron monitors were computed. Using these functions, the cutoff dependence of intensity variations for primary variation spectra of the form $p^{-\gamma}$ was calculated for different $\gamma$ values. The correction that has to be applied for the 11 year cycle is discussed. (auth)

**7448** ENERGY AND MASS SPECTRA OF SOLAR COSMIC RAYS. E. Schatzman (Institut d'Astrophysique, Paris). p.709-15 of "Space Research. III." New York, Interscience Publishers, 1963.

It is shown that the acceleration of charged particles in perpendicular hydromagnetic shocks gives the possibility of explaining the main features of solar cosmic rays: (1) it is better to describe the spectrum by an exponential law, with a fictitious temperature $T_f$, $kT_f$ being of the order of several $10^8$ ev. (2) There is a correlation between $T_f$ and the number of accelerated protons, with a tendency for $T_f$ to be larger when the number of accelerated protons is greater. (3) The proportion of $\alpha$-particles increases also with $T_f$. The connection between these three quantities is not a strict relation, but a correlation, as the physical parameters describing the structure of the outer layers of the sun are not constants (magnetic field, scale of the irregularities of the field). (auth)

**7449** SOLAR CORPUSCULAR STREAMS BY THE IGY DATA. V. I. Afanaseva and J. D. Kalinin (Inst. of Terrestrial Magnetism, Ionosphere and r.w. Propagation, Moscow). p.734-41 of "Space Research. III." New York, Interscience Publishers, 1963.

A catalog of storm families for the whole period of the IGY is presented. This catalog is similar to that for July 1959. For the IGY period 162 families covering 500 days out of the 549 days of the IGY were found. The catalog of storm families is regarded as a catalog of solar corpuscular streams causing geomagnetic activity. (auth)

**7450** MEASUREMENTS OF SOLAR X-RAY RADIATION. S. Mandelstam, B. Vasilev, J. Voron'ko, I. Tindo, and A. Shurygin (Lebedev Physical Inst., Moscow). p.822-35 of "Space Research. III." New York, Interscience Publishers, 1963.

The flux of solar x radiation below 10 Å was measured on July 21, 1959, by vertical flights of two geophysical rockets, on August 19-20, 1960, during the flight of the sputnik II, on December 1-2, 1960, during the flight of the sputnik III, and on February 15, 1961, by vertical flight of a geophysical rocket during the total phase of the solar eclipse. The results of the measurements are listed. (auth)

**7451** RESULTS ON GAMMA-RAY ASTRONOMY FROM EXPLORER XI. G. W. Clark and W. L. Kraushaar (Massachusetts Inst. of Technology, Cambridge). p.1087-96 of "Space Research. III." New York, Interscience Publishers, 1963.

A preliminary analysis of the data from Explorer XI indicates the probable existence of a cosmic gamma ray flux (energy $\gtrsim 100$ Mev) which, when averaged over all directions in space, has a value of about $5.5 \times 10^{-4}$ $cm^{-2}$ $sr^{-1}$ $sec^{-1}$. The analysis of these data has continued, and

the most recent flux estimate and evidence concerning arrival directions are reported. (auth)

**7452** COSMIC RAY EXPERIMENTS FOR EXPLORER XII AND THE ORBITING GEOPHYSICAL OBSERVATORY. George H. Ludwig and Frank B. McDonald (NASA Goddard Space Flight Center, Greenbelt, Md.). p.1129-43 of "Space Research. III." New York, Interscience Publishers, 1963.

The cosmic-ray experiment on Explorer XII consisted of a Geiger counter telescope, a thin CsI scintillation counter, and a large area scintillation counter telescope. The thin scintillation counter was connected to an 8-level integral analyzer. The large-area scintillation counter telescope, which measured the energy loss of the detected particles, was fed to a 32-channel differential pulse-height analyzer with a storage capacity of 65,535 counts per channel. Both the Geiger counter telescope and single counter rates were telemetered. All information was multiplexed onto a single channel. Details of the instrumentation and the methods of encoding are discussed. For the first Orbiting Geophysical Observatory mission, a new scintillation counter telescope was developed that measures both energy loss and total energy. This furnishes excellent charge and energy resolution over an energy range from about 11 to 90 Mev per nucleon. Design details of this telescope and its associated electronic instrumentation are also presented. (auth)

## Criticality Studies

**7453** (TID-19908) THE DENSITY EFFECT—IN REGARDS TO THE MINIMUM CRITICAL ENRICHMENT OF AQUEOUS HOMOGENEOUS URANIUM. O. W. Hermann (Union Carbide Nuclear Co. Paducah Plant, Ky.). Jan. 16, 1962. Contract W-7405-eng-26. 5p.

Each of the four factors involved in the expression for the infinite multiplication factor $k_\infty$ is shown to be independent of density. Hence, the minimum critical $U^{235}$ enrichment (defined for an infinite mass) is also independent of density. It is proposed that the basic criterion for minimum critical $U^{235}$ enrichment be extended to densities greater than 3.2 g U/ml for homogeneous uranium salts and uranium metal sawdust but not for heterogeneous systems. (D.L.C.)

## Direct Energy Conversion

**7454** (AD-292334) ION PRODUCTION AND FLOW IN AN ELECTROHYDRODYNAMIC GENERATOR (thesis). Terry N. Lauritsen (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). Aug. 1962. 98p.

An electrohydrodynamic (EHD) generator (electric instead of magnetic fields) was built, and the characteristics and trends of ion production and flow in the generator were determined. Air, partly ionized through the use of multiple corona discharge needles, was used for the working fluid. The results show that EHD conversion is possible and that multiple needle corona discharge is a practical method of ionization. (D.C.W.)

**7455** (AD-423257) THERMIONIC CONVERTER SURFACE CONDITIONS. Third Quarterly Technical Progress Report, August 1, 1963–October 31, 1963. (General Electric Co. Research Lab., Schenectady, N. Y.). Nov. 1963. Contract AF33(657)-10132. 22p.

An oxygen-treated tantalum emitter was prepared and operated in a parallel-plane cesium-vapor converter with a molybdenum collector in the high-pressure mode. The current voltage curves are very similar to those from a converter having a clean tantalum emitter when taken under similar conditions except for cesium pressure. The tube with the oxygen treated tantalum emitter operates at half the cesium pressure. Comparing this converter's output with the output of a converter with a tungsten emitter showed similar volt-ampere characteristics except less high current capability for the oxygen-treated tantalum emitter. (N.W.R.)

**7456** (ASD-TDR-63-4019) LONG-LIFE CLOSED-LOOP MHD RESEARCH AND DEVELOPMENT UNIT. R. L. Hundstad, F. A. Holmes, J. G. DeSteese, W. S. Emmerich, R. E. Voshall, L. R. Allen, and S. Way (Westinghouse Electric Corp., Pittsburgh). Sept. 6, 1963. Contract AF33 (657)-8311. 156p.

A closed loop MHD generator and motor research unit was designed and built to produce MHD conditions and provide experience in the operation of MHD generators suitable for space applications. During the course of construction, many experimental and analytical advances were made. Component parts of the machine were individually tested before assembly. After assembly the first test used helium and cesium as the working fluid. Future plans include tests with different vapors and duct materials together with the incorporation of non-thermal ionization and possibly superconducting magnets. Results of materials evaluations and performance tests are included. (auth)

**7457** (EUR-485.e) IN-PILE TEST OF A THERMIONIC CONVERTER. C. A. Busse, R. Caron, and E. W. Salmi (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1963. 15p. (CONF-370-1)

From Thermionic Converter Specialist Conference, Gatlinburg, Tenn., Oct. 1963.

A nuclear heated thermionic converter was tested at Ispra to study the temperature distribution in the converter under different operating conditions. The converter was principally constructed of Nb and $Al_2O_3$ with a cylindrical Mo emitter that was radiation heated from a (UZr)C fuel pin. The vacuum-contained converter was in thermal contact with the cooling water through three bridges. Measuring the temperature drop along these bridges allowed direct determination of the emitter lead losses and the converter efficiency. No currents notably higher than the vacuum saturation emission current were obtained, since the Cs heater failed in the check-out before the test. (auth)

**7458** (PWA-2125) INVESTIGATION OF MAGNETOHYDRODYNAMIC POWER GENERATION. VOLUME IV. MATERIALS. (Pratt and Whitney Aircraft Div., United Aircraft Corp., Hartford, Conn.). Dec. 1962. Contract AF30(602)-2487. 179p. (RADC-TR-62-464(Vol. IV))

The results of an investigation of materials for use in a MHD generator operating at wall temperatures in the range of 3000 to 4500°F are presented. The investigation consisted of a systematic evaluation of promising materials selected after an extensive literature survey. The program, which includes high-temperature laboratory measurements of material properties and the characteristic material performance under environmental operating conditions, was designed to select the best materials for this high temperature MHD application. The results include the experimental determination of electrical resistivity, thermal expansion, and strength of several refractory conductors and insulators. The results of chemical compatibility tests and the environmental testing program are also included. In addition, data are presented from an

investigation of tensile strength and tensile modulus of selected materials. 283 references. (auth)

**7459** (RTD-TDR-63-4170) SUPERCONDUCTING MAGNET RESEARCH AND APPLICATION TO MHD POWER GENERATORS. Final Report. R. R. Akers (Westinghouse Electric Corp. Astronuclear Lab., Pittsburgh); W. A. Stewart, T. C. Tsu, R. E. Kothman, and O. T. Beecher (Westinghouse Electric Corp. Research Labs., Pittsburgh). Dec. 31, 1963. Contract AF33(657)-10567. 377p.

A theoretical study of the application of large superconducting magnets to MHD generators used for space power generation is presented. The study determines the need for superconducting magnets in lieu of conventional magnets for this application. A suitable superconducting magnet-MHD generator system is developed, and optimum techniques and parameters are investigated for all components. This subsystem is then combined with state-of-the-art estimates of specific weights for developed turbine generator systems. These estimates give a final plant specific weight for a 1 Mw electrical generator, operating on a Rankine cycle and utilizing zinc as the working fluid. This system is then optimized with respect to magnetic field strength and field homogeneity. The final optimized system has a specific weight of 16 lb/kw. This calculation assumes no power penalty for pumps and auxiliary equipment. The magnetic field developed is in the range of 6 to 8 webers/$m^2$ with a maximum variation of field in the MHD channel volume of 10%. The magnet contribution to this weight is 3 lb/kw. 60 references. (auth)

**7460** IMPEDANCE OF A MAGNETOHYDRODYNAMIC GENERATOR WITH SMALL ELECTRODES. P. R. Smy (Univ. of British Columbia, Vancouver). Brit. J. Appl. Phys., 14: 936-7(Dec. 1963).

An expression is derived for the electrical impedance of a magnetohydrodynamic generator whose electrode surfaces are small in area and are flush with the insulating walls of the generator. The effects of charged layers on the walls are considered and it is shown that the impedance is the same as that obtained with external applied emf. The experimental significance of this result is discussed. (auth)

**7461** METAL-TO-CERAMIC SEALS FOR THERMIONIC CONVERTERS. R. S. Kiwak (Bendix Corp.: Southfield, Mich.), J. Ritz, and R. E. Hess. 20p. (CONF-202-5).

From The Electrochemical Society Fall Meeting, New York, Sept. 1963.

A feasibility study was undertaken to determine the best method for fabricating a metal-to-ceramic seal that can withstand 1500°C in cesium for a thermionic converter. Attempts were made to seal high purity alumina to the refractory metals by brazing, electroforming, electron beam welding, ultrasonic welding, diffusion bonding, and by a graded composite. The graded composite and the diffusion seal show the most promise. Hermetic seals were made that withstand 1500°C for several hours and remain hermetic. (auth)

**7462** LIQUID METAL VORTEX MHD GENERATOR. H. E. Weber (General Electric Space Sciences Lab., Prussia, Penna.) and C. H. Marston. New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-209, 9p, $1.00. (CONF-102-27)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

Use of liquid metal rather than ionized gas for MHD power generation offers the possibility of greatly increased magnetic interaction and power density, plus relatively low operating temperatures. A vortex configuration is proposed as a means of eliminating end losses, which become very important because of greatly increased electrical conductivity, and, at the same time minimizing fluid friction losses. This latter feature results from the decoupling of the work-producing tangential velocity from the fluid-transporting radial and axial velocities. A cylindrical annulus of liquid rotating in a radial magnetic field generates an electric current parallel to the axis of rotation. The radial field is sustained by a pair of opposed current coils at the ends of the cylinder. Rotation is maintained by high speed wet vapor of the same metal. Transfer of kinetic energy from vapor to rotating liquid is the primary problem which must be solved for practical realization of this concept. Two approaches are considered for the solution of the energy transfer problem. First, vapor can enter the liquid annulus tangentially near the outer periphery, transferring momentum as the bubbles pass radially inward. After crossing the inner, free surface, boundary of the annulus the vapor is exhausted axially. Second, a two-phase mixture of low quality can enter tangentially at the inner free surface. The liquid part of the mixture merges with the annular flow losing momentum as it passes radially outward to exhaust at the outer wall through a porous surface or diffuser. Peak conversion efficiencies of approximately thirty percent and forty percent are predicted for the first and second methods respectively. (auth)

## Elementary Particles and Radiations

**7463** (BNL-7407) PROPERTIES OF THE $\varphi$ MESON. P. L. Connolly, E. L. Hart, et al. (Brookhaven National Lab., Upton, N. Y.); M. Goldberg, et al. (Syracuse Univ., N. Y.). [1963]. Contract AT(30-2)-GEN-16. 12p. (CONF-216-2)

From International Conference on Elementary Particles, Siena, Italy, Sept.-Oct. 1963.

An investigation of the interactions $K^- + p \rightarrow \Lambda + K^0 + \bar{K}^0$ and $K^- + p \rightarrow \Lambda + K^+ + K^-$ at 2.24 Bev/c gave the following results for the mass, full width, parity, spin, and isospin of the meson ($\varphi$): 1020.5 ± 0.5 Mev, 3.1 ± 0.8 Mev, − 1, odd, and 0, respectively. The branching ratios $\Gamma(\varphi \rightarrow \pi^+ + \pi^-)/\Gamma(\varphi \rightarrow K + \bar{K})$ and $\Gamma(\varphi \rightarrow p + \pi)/\Gamma(\varphi \rightarrow K + \bar{K})$ were determined to be < 0.08 and 0.10 ± 0.10, respectively. The width for the $\omega \rightarrow 3\pi$ decay was estimated to be ≃ 0.05 Mev, while the cross section for $K^- + p \rightarrow \Lambda + \varphi$ with $\varphi \rightarrow K + \bar{K}$ was determined to be 56 ± 13 μb. The $\varphi$ production mechanism was also studied. (D.C.W.)

**7464** (BNL-7408) RESONANCE PRODUCTION IN THE $\Xi K\pi$ SYSTEM. P. L. Connolly, E. L. Hart, et al. (Brookhaven National Lab., Upton, N. Y.); M. Goldberg, et al. (Syracuse Univ., N. Y.). [1963]. Contract AT-30-2-GEN-16. 14p. (CONF-216-3)

From International Conference on Elementary Particles, Siena, Italy, Sept.-Oct. 1963.

Resonance production in $K^-$ + p interactions at 2.24 Bev/c yielding $\Xi - K - \pi$ final states was studied. Strong production of the $\Xi^*(1530)$, $K^*(885)$, and the new $K - \pi$ resonance ×(725) was observed, but little evidence for a resonance around 1600 Mev was noted. Evidence for possible structure in the overlap regions was also observed, and the isospin of the $\Xi^*$ was evaluated. The production and decay angular distributions of the $\Xi^*$ are discussed. (D.C.W.)

**7465** (BNL-7409) DECAY CHARACTERISTICS OF $\Xi^-$ AND $\Xi^0$ HYPERONS. P. L. Connolly, E. L. Hart, et al.

(Brookhaven National Lab., Upton, N. Y.); M. Goldberg, et al. (Syracuse Univ., N. Y.). [1962]. Contract AT-30-2-GEN-16. 16p. (CONF-216-4)

From International Conference on Elementary Particles, Siena, Italy, Sept.-Oct. 1963.

The decays $\Xi^- \rightarrow \Lambda + \pi^-$ and $\Xi^0 \rightarrow \Lambda + \pi^0$ of hyperons ($\Xi$) produced in $K^-$ + p interactions at 2.24 Bev/c were analyzed. The lifetime and mass of the $\Xi^-$ were determined to be $1.74 \times 10^{-10}$ sec and 1321.0 ± 0.5 Mev, respectively. A mass of 1316 ± 3 Mev was obtained for the $\Xi^0$, giving a mass difference ($\Xi^- - \Xi^0$) of 5 ± 3 Mev. The hyperon ($\Xi^-$) decay parameters $\alpha$, $\beta$, and $\gamma$ were also determined; the findings on $\Xi^-$ decay are discussed. Two instances of $\Xi^- \rightarrow \Lambda + e^- + \bar{\nu}$ decay were also observed. (D.C.W.)

**7466** (BNL-7509) STRUCTURE OF THE K-MESON DECAY INTERACTION. William J. Willis (Brookhaven National Lab., Upton, N. Y.). Sept. 1963. Contract AT-30-2-GEN-16. 30p. (CONF-231-4)

From International Conference on Fundamental Aspects of Weak Interactions, Upton, N. Y., Sept. 1963.

The presently available experimental information about the meson (K) decay interaction is reviewed. The charge dependence of the interaction is not discussed, and most of the interaction was obtained from the $K_{e3}$ and $K_{\mu 3}$ decays. (auth)

**7467** (CONF-340-12) MESON-BARYON RESONANCES IN THE OCTET MODEL. A. W. Martin and K. C. Wali (Argonne National Lab., Ill.). [1963]. Contract W-31-109-eng-38. 45p.

From American Physical Society 1963 Autumn Meeting, Chicago, Oct. 1963.

Elastic scattering of the pseudoscalar meson octet by the baryon octet is analyzed in the four lowest partial waves and in the six unitary-symmetry representations involved. The N/D method forms the basis of the dynamical treatment in an equal-mass approximation. The forces due to the exchange of the baryon octet, the $p_{\frac{1}{2}}$ decuplet, and the vector-meson octet give rise to additional resonances, along with the original baryon octet and $p_{\frac{3}{2}}$ decuplet. Effective coupling constants and masses for these resonances are determined from experiment and the resonances are reinserted as exchange diagrams into the dynamical calculation. Two cutoff parameters and the Yukawa-coupling mixing parameter (denoted by f) are the only adjustable constants. A consistent and closed system is obtained for $0.25 \leq f \leq 0.45$. It comprises a $p_{\frac{1}{2}}$ baryon octet, a $p_{\frac{3}{2}}$ decuplet, an $s_{\frac{1}{2}}$ singlet (tentatively identified as the 1405-Mev $Y_0^*$), and a $d_{\frac{3}{2}}$ singlet (tentatively identified as the 1520-Mev $Y_0^*$). No $d_{\frac{5}{2}}$ octet is predicted in this model. (auth)

**7468** (JINR-E-1441) ON A SLIGHT MODIFICATION OF HORI'S STRONG-COUPLING METHOD. G. Heber (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 6p.

The vacuum-expectation value of the S-matrix (with external sources) and the generating functional $\Omega$ of the S-matrix are written as Volterra series rather than in closed form to permit the numerous functional differentiations required in calculating higher-order Feynman amplitudes by Hori's method. (auth)

**7469** (JINR-P-1394) O ZAKONAKH SOKHRANENIYA CHISLA CHASTITS. (On Conservation of the Number of Particles). V. N. Streltsov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1963. 5p.

The possibility is indicated of introducing only two laws for the conservation of the number of particles—the conservation law of the fermion charge (f) and that of the electron charge ($l$)—instead of the three laws (conservation of lepton, baryon and muon charges). The fermions are characterized by f = 1; antifermions by f = −1; $e^-$ and $\nu_e$ by $l$ = 1; and $\mu^-$ and $\nu_\mu$ by $l$ = L. Different possibilities of the choice of L are discussed. (auth)

**7470** (JINR-P-1423) O SREDNEM VREMENI ZHIZNI DOLGOZHIVUSHCHEGO $K^0$-MEZONA. (On a Lifetime of a Long-Lived $K^0$-Meson). E. O. Okonov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1963. 8p.

Different methods of measuring the lifetime ($\tau_2$) of the meson ($K^0$) are considered, and some erroneous determinations of $\tau_2$ are cited. On the basis of recent experimental data, the lifetime is estimated to be $6.8 \times 10^{-8}$ sec. (auth)

**7471** (JINR-P-1434) TEORIYA KOMPLEKSNYKH UGLOVYKH MOMENTOV I FIZIKA VYSOKIKH ENERGII. (Theory of Complex Angular Momenta and High-Energy Physics). G. Domokos (Domokosh), R. Ja. (Ya.) Zulkarneev, and V. I. Nikanorov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems and Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 25p.

An elementary description of the complex angular momentum theory is given, and some applications of the theory are indicated. (auth)

**7472** (NP-13451) APPLICATIONS OF DISPERSION RELATIONS TO PION-NUCLEON AND PION-PION PHENOMENA. Lecture Given by J. Hamilton at Universitetets Institut for Teoretisk Fysik and NORDITA Copenhagen. (London. Univ. University Coll. and Nordisk Institut for Teoretisk Atomfysik, Copenhagen). 1963. 174p.

The use of forward and fixed momentum transfer dispersion relations to determine the main parameters of low energy $\pi$-N physics from the experimental data to predict low energy $\pi$-N phase shifts (primarily in terms of the known $\pi$-N resonances) is described. Some general problems that arise in this method are discussed. It is then shown that partial wave $\pi$-N dispersion relations can be used to derive information about the low energy $\pi$-$\pi$ interactions, especially the T = O J = O $\pi$-$\pi$ interaction. The analysis of s-wave and p-wave $\pi$-N scattering in terms of the several interactions that cause the scattering is given. Finally, various topics in the solution of partial wave dispersion relations are considered. The validity of the N/D method and the effect of high energy boundary conditions on N/D solutions are examined. Also, a variational method for the solution of partial wave dispersion relations is developed and applied in a semiphenomenological way to give solutions for the $(^3/_2, ^3/_2)$ $\pi$-N resonance and the T = 1 J = 1 $\pi$-$\pi$ resonance ($\rho$). 68 references. (auth)

**7473** (ORNL-3499(Vol.II)(p.7-9)) STUDIES OF THE CREATION OF POSITRONS IN TARGETS BY A 1-Gev ELECTRON BEAM. C. D. Zerby and H. S. Moran (Oak Ridge National Lab., Tenn.).

The electron-photon cascade calculation was used to calculate the generation of positrons in 3-radiation-length-thick targets bombarded by a narrow 1-Bev electron beam. The materials considered were lead, tin, copper, and aluminum, with lead yielding the largest conversion of incident electrons into positrons. For the lead target the ratio of electrons to positrons is always greater than unity, and their energy distributions appear to be similar in shape. Radial distributions of the positrons and electrons in the lead were also calculated. (auth)

**7474** (ORNL-3499(Vol.II)(p.23-4)) AN IMPROVED CODE FOR THE NUMERICAL ANALYSIS OF A NUCLEON-

MESON CASCADE. R. G. Alsmiller, Jr., F. S. Alsmiller, and J. E. Murphy (Oak Ridge Gaseous Diffusion Plant, Tenn.).

Work on an IBM-7090 program to solve the nucleon-meson cascade equations in the straightahead approximation continued. The part of the program dealing with incident beams that have a continuous spectrum was completed. (auth)

**7475** (TID-19854) RADIATIVE PION-NUCLEON SCATTERING. P. Carruthers (Cornell Univ., Ithaca, N. Y. Lab. of Nuclear Studies and Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Nov. 1963. Contracts AT(30-1)-2179 and NONR 401-51. 19p.

The cross section for bremsstrahlung in $\pi$-N interactions is calculated from the results of the static nucleon theory. The result agrees well with a recent measurement of the reaction $\pi^+ + p \rightarrow \pi^+ + p + \gamma$ at an average pion laboratory kinetic energy of about 300 Mev. The theoretical result is 0.25 mb, compared to the experimental value 0.22 ± 0.05 mb. The energy distribution of the final pion is computed at laboratory energies of 200, 300, and 400 Mev. The 3-3 isobar shows up clearly at the latter two energies, in agreement with experiment. Experiments are suggested whereby the bremsstrahlung can be used as a probe to obtain information about the higher resonances in $\pi$-N scattering. (auth)

**7476** COMPLEX ANGULAR MOMENTUM IN THE NON-RELATIVISTIC POTENTIAL SCATTERING. A. H. Voelkel (Universität, Hamburg). Acta Phys. Austriaca, 17: 3-17(1963).

The analytic properties of the partial wave amplitudes in energy and angular momentum for nonrelativistic potential scattering are discussed. The formal theory of scattering is reviewed in terms of Green's functions. Analyticity in energy and angular momentum for the partial waves and wave properties of the singularities are proved. Some conclusions from the theory of resonances and the analytic and asymptotic properties of the scattering amplitude in the momentum transfer variable are discussed. (M.C.G.)

**7477** A QUALITATIVE SURVEY ON HIGH ENERGY ELASTIC SCATTERING AND REGGE POLES. R. Hagedorn (CERN, Geneva). Acta Phys. Austriaca, 17: 18-28(1963).

The fact that in p-p elastic scattering the diffraction peak shrinks logarithmically with the center-of-mass energy squared is analyzed in terms of Regge poles. Kinematics, crossing symmetry, analyticity, partial wave expansion of analyticity function, and the black sphere are discussed. Experiments are described. (M.C.G.)

**7478** ASYMPTOTIC BEHAVIOUR OF PHASE SHIFT FOR LARGE $\lambda$. B. Jakšić (Institut "Rudjer Bošković," Zagreb). Acta Phys. Austriaca, 17: 29-36(1963).

A simple method for obtaining the asymptotic behavior of phase shift for large $\lambda$ is shown. The WBK method is avoided entirely. (M.C.G.)

**7479** REGGE POLES AND MULTIPLE PRODUCTION. Kenneth G. Wilson (CERN, Geneva). Acta Phys. Austriaca, 17: 37-44(1963).

Interactions at high energies are discussed in terms of the Regge pole for elastic scattering and the multiperipheral model of Amati et al., for highly inelastic processes. Questions to be asked about high-energy interactions and theories that are relevant to each question are listed. (M.C.G.)

**7480** THE DETERMINATION OF PARTIAL WAVE AMPLITUDES FROM DISPERSION RELATIONS IN THE PRESENCE OF INELASTIC SCATTERING. P. Beckmann (Institut für Kernphysik, Mainz). Acta Phys. Austriaca, 17: 45-55(1963).

A way in which the problem of determining partial wave amplitudes from dispersion relations in the presence of inelastic scattering can be reduced to an equivalent purely elastic problem if the imaginary part of the scattering phase shift is assumed to be known is reviewed. A procedure to solve the elastic problem is discussed showing the inherent ambiguities. (auth)

**7481** UPPER BOUND ON THE GROWTH OF SCATTERING AMPLITUDE AT HIGH ENERGY. Toichiro Kinoshita (CERN, Geneva). Acta Phys. Austriaca, 17: 56-64(1963).

Improvement of Froissart's bound on the growth of the scattering amplitude at high energies is discussed. For simplicity, the scattering of spinless particles of equal mass was considered. (M.C.G.)

**7482** AN AXIOMATIC FRAME FOR POTENTIAL SCATTERING. G. Berendt (Universität, Berlin). Acta Phys. Austriaca, 17: 65-71(1963).

In the case of the scattering of a nonrelativistic particle by a quantum-mechanical system with several energy terms a set of equations is given, with which it is possible to derive a condition of the Low type for the S-matrix without any reference to a potential in explicit form, if in addition certain boundary values of the above mentioned set of equations are given. (auth)

**7483** COMPLEX ENERGY AND COMPLEX ROTATION PULSE IN THE PRESENCE OF NONCENTRAL POTENTIALS. K. Ringhofer and P. Urban (Universität, Graz). Acta Phys. Austriaca, 17: 96-108(1963). (In German)

In connection with the work of Bottino, Longoni, and Regge, the potential scattering for complex energies and for complex rotation pulses in the presence of LS and tensor potentials was investigated. The regular solution could previously only be investigated for potentials which were in the zero point better than 1/r. The Yukawa potential (and some somewhat unfavored potentials) was investigated. It was found that in the case of coupled Schroedinger equations exactly the same behavior relative to the energy variables results as for scattering of spinless particles. With regard to the rotation pulse, it cannot be continued essentially above $\mathrm{Re}\, j = \frac{1}{2}$ to $\mathrm{Re}\, j < \frac{1}{2}$ without divergence of the Neumann series for the regular solution. The convergence of the partial wave development was also investigated. (tr-auth)

**7484** HIGH ENERGY SCATTERING IN SYSTEMS WITH ANOMALOUS THRESHOLDS. G. Domokos (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Polon., 24: 345-50(Sept. 1963).

An S-matrix-treatment of high-energy scattering is given in the presence of anomalous thresholds. The high-energy behavior of the elastic amplitudes is governed by the Pomeranchuk pole. In the case of the scattering on a nucleus, the amplitude is proportional to the atomic number. Besides the scattering on individual constituents of the target, a non-vanishing coherent scattering on the target as a whole is found. The possible role of many-nucleon intermediate states is briefly discussed. (auth)

**7485** ANGULAR DISTRIBUTION IN $\Pi \rightarrow \mu + \nu$ DECAY. PART II. E. Frota Pessôa and N. Margem (Centro Brasileiro de Pesquisas Fisicas and Faculdade Nacional de Filosofia, Rio de Janeiro). Anais Acad. Brasil. Cienc., 35: 165-8(June 1963).

A study of the angular distribution of 8669 $\mu$ mesons resulting from II decay at rest in nuclear emulsion is made using area scanning, looking for $\mu$ ends. The results give no backward-forward asymmetry, contrasting with other results obtained in the same plates with area scanning, looking for II – $\mu$ vertices. Thus the conclusion that the backward-forward asymmetry found in these plates was due to bias is enforced. (auth)

**7486** ON THE NATURE OF ANOMALOUS LIFETIME COMPONENTS OF POSITRONS OBSERVED IN SOME SOLIDS. Teuvo Kohonen (Inst. of Tech., Helsinki). Ann. Acad. Sci. Fennicae, Ser. A VI, No. 130, 1-15(1963).

Lifetimes of positrons that diffuse in various solids were measured. Their exponential distribution was found to possess a longer tail component with a low intensity (a few per cent or less) even in such media where its occurrence was forbidden by the usual theories. The observed components resemble those due to bound positron states in amorphous solids and liquids. Measurements were performed in Al, Cu, Pb, In, Ge, and NaCl. The art of preparation of the positron emitter onto the sample showed the largest effect. In fused NaCl and with a homogeneously distributed positron source the tail disappeared. Cooling down to the temperature of liquid nitrogen caused a decrease in the tail. (auth)

**7487** A PROPOSED MINIMAL PRINCIPLE GOVERNING ELECTRON DYNAMICS. Mostafa A. Abdelkader. J. Electron. Control (1), 15: 419-35(Nov. 1963).

The motion of photoelectrically liberated electrons in a vacuum in the neighborhood of conducting bodies is investigated, the forces acting on them being due solely to the redistribution of the free electrons of the conductors, which is brought about by the motion of the photoelectrons themselves. A new method of treating a layer of slowly moving space-charge is presented. The energy equation pertinent to the motion is then set up and shown to depend directly and uniquely upon the exact force-law for two moving point-charges, that is, the generalized Coulomb law. In looking for such a law, it is found that the classical Maxwell-Lorentz electromagnetic theory yields the Liénard-Schwarzschild force-formula, which is not accepted as true. The only known alternative formula is that due to Ritz and based on his ballistic electrodynamics; but then, this is only an approximation to an unknown exact formula. The inevitable conclusion is that the generalized Coulomb law is yet to be discovered, and this circumstance permits us to consider the very natural possibility that electrons behave in accordance with a sort of a least effort principle, namely, that the inter-charge forces are such that the electrons tend to preserve as much as possible their initial kinetic energies. The loss in their kinetic energies will appear as heat and radiation, and these will accordingly be minima. Calculations based upon this principle give results that are amenable to test in the laboratory. (auth)

**7488** INTEGRAL REPRESENTATIONS FOR VERTEX FUNCTIONS. C. Fronsdal and R. E. Norton (Univ. of California, Los Angeles). J. Math. Phys. (N. Y.), 5: 100-8(Jan. 1964).

The third-order Feynman graph is studied as a function of the three external masses squared for arbitrary real values of the internal masses. Single and double dispersion relations are derived that, for arbitrary real values of the undispersed variables, involve integrations only over real contours. Spectral functions for both the single and double integral formulas are listed. In several cases, a non-Landau singularity (on the forward scattering curve) appears on the physical sheet, but not as a singularity of the physical boundary value. (auth)

**7489** POLES IN COUPLED SCATTERING AMPLITUDES. A. J. Dragt (Univ. of California, Berkeley) and R. Karplus. J. Math. Phys. (N. Y.), 5: 120-6(Jan. 1964).

Elastic scattering amplitudes which have the analytic structure of the Mandelstam representation and which satisfy the unitarity condition and substitution law are severely restricted. Because of these restrictions, poles cannot occur independently and arbitrarily in amplitudes coupled by the unitarity condition. Instead, the locations and residues of poles in coupled amplitudes must satisfy the same relations as do poles in perturbation theory amplitudes. (auth)

**7490** MOTION OF A RELATIVISTIC DAMPED OSCILLATOR. R. A. Struble and T. C. Harris (North Carolina State Univ., Raleigh). J. Math. Phys. (N. Y.), 5: 138-41(Jan. 1964).

Quantitative effects of damping in a nonlinear system are illustrated for the case of a relativistic oscillator. The elementary techniques employed furnish details of the decay phenomena that are more extensive than those normally furnished by stability theorems. (auth)

**7491** APPROXIMATE CALCULATIONS OF SCATTERING PHASE SHIFTS. Walter R. Sooy (Univ. of California, Los Angeles). J. Math. Phys. (N. Y.), 5: 147-? (Jan. 1964).

The nonrelativistic scattering problem is reformulated by transforming the partial-wave equation into similarity with the corresponding equation for a known or soluble problem. It is shown that if the potentials for the two cases are sufficiently close (within about 10% typically), a particularly simple and accurate expression for the desired phase shifts can be written. Numerical examples for a Gaussian potential are given. The method is also extended to the calculation of bound-state energy levels, but no numerical examples are given. (auth)

**7492** ELEMENTARY PARTICLES. III. STRANGE PARTICLES AND AN EXPLANATION OF THEIR PROPERTIES. J. M. Lévy-Leblond (CNRS, Orsay, France). Nature (Paris), No. 3339, 287-95(1963). (In French)

The discovery of the strange particles and the theoretical implications thereof are reviewed, along with the concepts that permit the analysis of strange particle behavior and properties. (D.C.W.)

**7493** A NOTE ON THE GENERAL FORM OF THE PSEUDOSCALAR INTERNUCLEON POTENTIAL. P. Herczeg (Inst. of Physics, Czechoslovak Academy of Science, Prague). Nucl. Phys., 48: 263-6(Oct. 1963).

A derivation of the general form of the static and velocity dependent pseudoscalar inter-nucleon potential is given. It is shown that a further term must be added to the potential discussed by Blin-Stoyle and by Gammel and Thaler. (auth)

**7494** PHASE SHIFTS FOR LOW ENERGY SCATTERING. L. Wojtczak (Univ. of Łódź, Poland). Nucl. Phys., 48: 325-8(Oct. 1963).

A method of calculating low energy scattering phase-shifts is given. A numerical comparison is made for wells of Gaussian, exponential and Yukawa shape. (auth)

**7495** ANGULAR MOMENTUM ANALYSIS OF PHOTOPRODUCTION OF PION PAIRS FROM A NUCLEON. S. K. Srinivasan (Indian Inst. of Tech., Madras) and K. Venkatesan. Nucl. Phys., 48: 337-44(Oct. 1963).

The photoproduction of pion pairs is investigated by

analysis of the matrix element in terms of the angular momentum and isospin states. The integral equation for the production amplitude is solved under certain broad assumptions and an estimate of rescattering correction arising out of the many particle intermediate states is obtained and shown to be small at least in the sub-Bev region. The effect of pion-pion resonance is shown to be small for energies up to about 700 Mev of the incident photon. (auth)

**7496** ON THE MASSES OF THE TWO-PARTICLE RESONANCE SYSTEMS. K. V. L. Sarma (Tata Inst. of Fundamental Research, Bombay). Nuovo Cimento (10), 30: 28-32(Oct. 1, 1963).

An empirical regularity was pointed out between the masses of the two-particle resonance systems and the relative orbital angular momentum values. The simple relation used here can be seen to be in accord with a similar relation given by Regge for non-relativistic scattering. (auth)

**7497** DALITZ-PAIR DECAY MODES OF THE $\omega$, $\rho$, AND $\eta$ MESONS. D. Bessis, M. Jacob, and A. Morel (CEN, Saclay, France). Nuovo Cimento (10), 30: 112-16 (Oct. 1, 1963).

The $\omega$ and $\eta$ mesons are known to decay with emission of $\gamma$ rays. Dalitz-pair production occurs and could be used to identify such decay modes in hydrogen bubble chamber data. The branching ratio for Dalitz-pair formation as compared to $\gamma$-ray emission is calculated for all such processes that could be observed. (auth)

**7498** INFORMATION THEORY AND MULTIPLE PARTICLE PRODUCTION. Q. A. M. M. Yahya (Imperial Coll., London). Nuovo Cimento (10), 30: 143-50(Oct. 1, 1963).

It is shown that some results of information theory provide useful information about probabilities of some final states in typical reactions like $\pi$-N collision and p-$\bar{p}$ annihilation. The validity of a statistical model can be judged by checking whether the data satisfy the inequalities proved in the two theorems. Other possible uses of information theory are discussed. (auth)

**7499** PHOTO-PRODUCTION OF PIONS FROM NUCLEONS IN THE STRIP APPROXIMATION. S. K. Srinivasan (Indian Inst. of Tech., Madras) and K. Venkatesan. Nuovo Cimento (10), 30: 151-62(Oct. 1, 1963).

The amplitude for photoproduction of pions from nucleons is studied using Mandelstam representation. Coupled integral equations involving the absorptive parts and the double spectral functions were set up using the strip approximation of Chew and Frautschi. (auth)

**7500** THE STRIP APPROXIMATION AND THE PHOTO-PRODUCTION OF PIONS ON PIONS. S. K. Srinivasan (Indian Inst. of Tech., Madras) and K. Venkatesan. Nuovo Cimento (10), 30: 163-70(Oct. 1, 1963).

The usefulness of the strip approximation is examined with reference to the amplitude for the photoproduction of pions on pions. Using the solution of Solov'ev et al., the inelastic contributions are evaluated in the strip region and shown to be negligibly small in the asymptotic region of the s-channel. It is also shown that the same result holds good in the case of pion-pion scattering. (auth)

**7501** HIGH-ENERGY BEHAVIOUR IN PERTURBATION THEORY. I. G. Halliday (Cambridge Univ., Eng.). Nuovo Cimento (10), 30: 177-92(Oct. 1, 1963).

The high-energy behavior due to contributions from the edge of the hypercontour of integration of a large class of Feynman graphs is determined. It is shown that the sum of the leading terms of graphs with a certain type of iterated structure has a high-energy behavior consistent with Regge poles that tend to $l = -1, -2, -3, \ldots$ as the coupling constant tends to zero. Expressions are obtained for the trajectories and residues of these associated Regge poles. (auth)

**7502** PION-PION SCATTERING IN THE STRIP APPROXIMATION. [PART] I. B. H. Bransden (Univ. of Glasgow), P. G. Burke, J. W. Moffat, R. G. Moorhouse, and D. Morgan. Nuovo Cimento (10), 30: 207-29(Oct. 1, 1963).

Results of calculations on pion-pion scattering in the strip approximation are presented. A cutoff is made to avoid divergences at high energy. The starting point is an assumed form for the low partial waves based on experiment, supplemented by partial-wave solutions of the pion-pion problem. The spectral functions are calculated, and two sets of predictions are made. Firstly, higher elastic partial waves, in particular the D-waves, are evaluated, as are also the low-energy inelastic partial waves. These predictions are relatively insensitive to the cutoff. Secondly, Regge trajectories are deduced from the asymptotic behavior of the spectral functions. These do depend critically on the cutoff and the object is so to adjust the action of the cutoff as to reproduce the expected properties of the trajectories. This is partially successful. Solutions are found in which the $I = 0$ trajectory passes approximately through $l = 1$ at $t = 0$ and that at the same time gives a reasonable reproduction of the $\rho$ resonance in the $I = 1$ state. The bootstrap mechanism for the $\rho$ resonance is only possible when a substantial $I = 0$ D-wave at fairly high energy is included in the input. This is identified with the $f^0$ resonance recently observed. The $f^0$ itself is not reproduced although the low-energy $I = 0$ D-wave is probably well given by the theory. The predictions for diffraction scattering do not appear to be satisfactory and reasons are given for this. The slope found for the Pomeranchuk trajectory at $t = 0$ is $d\,\mathrm{Re}\,\chi/dt \sim 0.3\ (\mathrm{Bev}/c)^{-2}$ and a similar slope is found for the $I = 1$ trajectory. It is argued that the low-energy partial waves should be relatively insensitive to these features of the high-energy theory. (auth)

**7503** PERIPHERAL ANALYSIS OF DOUBLE-PION PRODUCTION IN PROTON-PROTON COLLISIONS. E. Ferrari (CERN, Geneva). Nuovo Cimento (10), 30: 240-58(Oct. 1, 1963).

Different reactions of double-pion production in proton-proton collisions at 2.00 and 2.85 Bev are discussed from the point of view of the peripheral mechanism of interaction. It is found that the two types of peripheral diagrams that can occur (where the two pions come out from different vertices and from the same vertex, respectively) are both important for the description of these reactions. It is also shown that the off-shell corrections cannot be neglected. The comparison with experiment, and the discussion of the points of agreement and discrepancy are carried out in detail. (auth)

**7504** LEADING LANDAU CURVES OF SOME FEYNMAN DIAGRAMS. J. N. Islam (Cambridge Univ., Eng.). Nuovo Cimento (10), 30: 259-65(Oct. 1, 1963).

It is shown that the leading Landau curves of some Feynman diagrams possess no parts associated with positive Feynman parameters when some of the external and internal masses satisfy certain inequalities. The assumed validity of the Mandelstam representation then

implies that the corresponding leading curves are non-singular on the physical sheet. (auth)

**7505** LINEAR RESPONSE, DENSITY OSCILLATION AND TWO-PARTICLE GREEN'S FUNCTION OF FERMION SYSTEMS. [PART] I. L. Pičman (Nuclear Inst. "Jozef Stefan," Ljubljana, Yugoslavia). Nuovo Cimento (10), 30: 321-39(Oct. 1, 1963).

The analyticity properties of a two-particle temperature-dependent equilibrium Green's function are studied through the representation in a Fourier series. The branch cuts of the Fourier coefficient $\tilde{g}_2(E_1E_2, E_3E_4)$ are determined by the help of spectral decomposition. It is shown that the response of a particle density of an external field is determined essentially by the spectral functions of $g_2$. These functions are in fact discontinuities across different branch cuts of $\tilde{g}_2$. The spectral functions that one needs for the study of density oscillation can be expressed with some functions $F_m$, which are simply connected with $\tilde{g}_2$. From a kind of Bethe-Salpeter equation, a system of integral equations is derived for the functions $F_m$. The kernels in these equations are vertex functions that can be determined by means of perturbation theory. (auth)

**7506** A MODEL OF THE PSEUDOSCALAR AND VECTOR MESONS. R. H. Capps (Università, Rome). Nuovo Cimento (10), 30: 340-53(Oct. 1, 1963).

The boostrap model, in which the V (vector) mesons are considered as self-generating poles in the P-wave, two-particle scattering amplitudes of PS (pseudoscalar) mesons, is extended so that the PS-mesons develop as poles in the amplitudes of one PS and one V-meson. It is conjectured that the V-meson exchange force is essential for the production of these poles. It is shown that this conjecture is consistent with the octet model of unitary symmetry, but inconsistent with the existence of only the $\pi$ and $\rho$-meson, and inconsistent with other possible systems containing a small number of types of particles. The conjecture also requires that the V + PS states be coupled to the PS + PS states in the amplitudes giving rise to the V-meson poles. (auth)

**7507** HIGH-ENERGY REACTIONS WITH EXCHANGE OF STRANGENESS-CARRYING TRAJECTORIES. H. Ueberall (Univ. of Michigan, Ann Arbor). Nuovo Cimento (10), 30: 366-77(Oct. 1, 1963).

On the basis of the Regge pole hypothesis, some two-body reactions of spin-zero particles interacting with protons are discussed in the high-energy limit that involve the exchange of strangeness-carrying trajectories. The differential forward cross-sections and the polarization of the recoiling fermion are obtained, and the consequences of Gell-Mann's line reversal and of the factorization principle are considered. The experimental angular distribution of $K^- + p \rightarrow \Sigma^+ + \pi^-$, although at relatively low energy, may be fitted with a one-trajectory formula. (auth)

**7508** AN ELECTRODYNAMIC APPROACH TO THE ELECTRON-MUON MASS RATIO. Th. A. J. Maris (Univ. of Illinois, Urbana). Nuovo Cimento (10), 30: 378-84 (Oct. 1, 1963).

By a mechanism well known from the theory of superconductivity the particles of an electrically charged massless fermion field may obtain a nonvanishing rest mass. If the mass renormalization in ordinary quantum electrodynamics is infinite, then it seems likely that a proper reformulation of the basic equations of quantum electrodynamics that eliminates the infinite constant $\delta_m$ will be a dilatationally-invariant theory corresponding to the model above. The dilatation invariance of the basic theory is not objectionable and opens on the contrary a natural possibility to understand how two leptons can have almost identical interactions but vastly different masses. The mass of a lepton is then determined by the nondilatationally-invariant perturbation caused by the other charged fields present in nature. (auth)

**7509** SOME REMARKS ON THE POSITION OPERATOR IN IRREDUCIBLE REPRESENTATIONS OF THE LORENTZ-GROUP. W. Weidlich and A. K. Mitra (Freie Universität, Berlin). Nuovo Cimento (10), 30: 385-98 (Oct. 1, 1963).

The form of the position operator for relativistic particles in different spinor bases is derived and its uniqueness is proved. The transformation properties of the position operator under all Lorentz transformations and their physical meaning are considered. (auth)

**7510** UNITARY PARITY. Y. Dothan (Israel Atomic Energy Commission, Rehovoth). Nuovo Cimento (10), 30: 399-405(Oct. 1, 1963). (IA-838)

The invariance groups of unitary symmetry are enlarged so as to include the discrete operation of charge conjugation. It is shown that members of the same unitary super-multiplet $(\lambda,\lambda)$ with baryon number zero are characterized by one and the same additional quantum number $\varphi$ that can take on the values $\pm 1$. (auth)

**7511** PERTURBATION EXPANSION WITHIN UNITARY SYMMETRY. J. Ginibre (Laboratoire de Physique Théorique et Hautes Energies, Orsay, France). Nuovo Cimento (10), 30: 406-25(Oct. 1, 1963).

The number of parameters that occur in perturbation expansions of masses and electromagnetic quantities within unitary symmetry is calculated. The contributions of the various irreducible parts in the second order mass formula are then separated and properly normalized; this allows a comparison of the relative magnitude of the different orders of perturbation in the physically interesting cases. (auth)

**7512** SOME REMARKS CONCERNING ANTIHYPERON-HYPERON PRODUCTION BY ANTIPROTONS IN HYDROGEN. J. Nuyts (CERN, Geneva) and E. de Rafael. Nuovo Cimento (10), 30: 443-9(Oct. 1, 1963).

Hyperon pair production in antiproton-proton annihilations in the momentum range 3-4 Bev/c is considered. Consequences of the possible polarization of the antiproton beam are investigated. Two correlation functions to determine whether the antiproton beam is polarized are proposed. Numerical results are given for $\bar{p} + p \rightarrow \bar{\Lambda} + \Lambda$ on the assumption of $K^*$ exchange. (C.E.S.)

**7513** BOOTSTRAPS AND COMPOSITENESS CONDITIONS. J. S. Dowker (Univ. of Pennsylvania, Philadelphia) and J. E. Paton. Nuovo Cimento (10), 30: 450-3 (Oct. 1, 1963).

The equivalence of the bootstrap method and arguments of a field theoretic nature that the renormalization constants $Z_1 = Z_3 = 0$ be the conditions for a particle to be composite, is considered. (C.E.S.)

**7514** FEASIBLE COMPLETE EXPERIMENTS OF PION PHOTOPRODUCTION. M. Kawaguchi, H. Shimoida, Y. Sumi, and T. Ueda (Osaka Univ.). Nuovo Cimento (10), 30: 454-7(Oct. 1, 1963).

Four independent experiments on meson ($\pi$) photoproduction on nucleons are discussed. The experiments include two differential cross sections with linearly polarized $\gamma$ rays, the polarization of the recoil nucleon, and the

differential cross section on a polarized nucleon target. (C.E.S.)

**7515** DIFFRACTION SCATTERINGS AT HIGH ENERGY AND POSSIBILITY OF NEW REGGE-TRAJECTORIES. S. Minami and K. Mori (Louisiana State Univ., Baton Rouge). Nuovo Cimento (10), 30: 458-61(Oct. 1, 1963).

The shrinking diffraction peak in p-p scattering and the non-shrinking diffraction peak in $\pi^{\pm}$-p scattering are discussed with respect to the validity of the Regge pole concept and possible new Regge trajectories that are not as yet established. Predictions are made concerning the diffraction peak for $K^{\pm}$-p scattering. (C.E.S.)

**7516** THE PRINCIPLE OF EQUIVALENCE OF ELEMENTARY PARTICLES AND THE GROUP-THEORETICAL CLASSIFICATIONS. M. J. Moravcsik (Laboratori Nazionali di Frascati, Rome). Nuovo Cimento (10), 30: 466-8(Oct. 1, 1963).

The four models $SU_3$, $G_2$, $C_2$, and $B_2$, based on the elementary particle irreducible representation of groups of rank two, are considered. It is shown that only $C_2$ satisfies the principle of equivalence. (C.E.S.)

**7517** THEORETICAL PREDICTION OF NEW HEAVY BOSONS (ESPECIALLY HEAVY K-MESONS) IN THE FRAME OF THE ROTATOR MODEL OF ELEMENTARY PARTICLES. F. Halbwachs and J. P. Vigier (Institut Henri Poincaré, Paris). Nuovo Cimento (10), 30: 469-75 (Oct. 1, 1963).

A rotator model of elementary particles that leads to the introduction of an isobaric group that has the four baryonic particle states n, p, Λ, and $V^+$ as basic states is considered. Heavier baryons are built from the "fusion" of three such basic states. New bosons and hyperons are predicted and physical identifications are made. (C.E.S.)

**7518** SPECTROSCOPY OF BARYONS AND RESONANCES CONSIDERED AS QUANTIZED LEVELS OF A RELATIVISTIC ROTATOR. G. Barbieri, S. Depaquit, and J. P. Vigier (Institut Henri Poincaré, Paris). Nuovo Cimento (10), 30: 476-9(Oct. 1, 1963).

A tentative table of baryons and baryonic resonances is presented. The baryon levels characterized by a given set of quantum numbers define bosons as the particles emitted when the relativistic rotator undergoes certain quantized jumps between given baryon levels. Bosons appear in the model in a similar way to the photons emitted in the quantum transitions of the Bohr theory of the hydrogen atom. (C.E.S.)

**7519** SOME PROPERTIES OF CUT-OFF IN HIGH-ENERGY COLLISIONS. G. Wataghin (Università, Turin). Nuovo Cimento (10), 30: 483-6(Oct. 1, 1963).

It is shown that the strong damping (cutoff) of the invariant momentum transfer in high-energy collisions, both elastic and inelastic, is related to a property of the three-momenta of physical particles outgoing or ingoing in a vertex-point. If the three-momenta p of physical particles are measured in conveniently defined vertex-frames of reference, their differential spectrum is statistically cutoff at values > M and their average values satisfy the relation $(|p|) \leq M$, where M is the proton mass. (C.E.S.)

**7520** THE INTERACTIONS OF UNSTABLE PARTICLES. Z. Fraenkel (Weizmann Inst. of Science, Rehovoth, Israel). Nuovo Cimento (10), 30: 512-21(Oct. 16, 1963).

The interactions of unstable particles with nucleons are examined. Such interactions can occur in high-energy nuclear reactions and as final-state interactions of elementary particle processes. The interactions of two strange unstable particles $Y_0^{*}$ and $K^{*}$ are discussed as an example. It is found that particles of narrow width, such as the $Y_0^{*}$, which are created inside the nucleus, have a good chance of escaping from the nucleus before they decay and may thus be detected experimentally. This is not true for particles of large width. Of particular interest for final-state interactions are the sharp resonance-like peaks that may occur in the cross sections of some of the interactions of unstable particles. These peaks are not associated with resonances but are related to the anomalous thresholds encountered in the interactions of loosely bound particles. (auth)

**7521** INTERPLAY OF COMPETING RESONANCES. B. d'Espagnat and F. M. Renard (Laboratoire de Physique Théorique et des Hautes Energies, Orsay, France). Nuovo Cimento (10), 30: 536-50(Oct. 16, 1963).

Final-state interactions in the $\theta_1 + \theta_2 + N$ system with the possibility of the reactions $\theta_1 + N \rightleftharpoons V_1$ and $\theta_2 + N \rightleftharpoons V_2$ are studied. An integral equation and a variational method for approximating it are examined. Overlapping effects of one resonance on the other are obtained. (auth)

**7522** REMOVAL OF THE DIVERGENCE IN ZERO MOMENTUM-TRANSFER DISPERSION RELATIONS. D. Atkinson (University Coll., London). Nuovo Cimento (10), 30: 551-64(Oct. 16, 1963).

A conformal mapping of the scattering cosine of an elastic scattering process is used to remove a divergence caused by crossed channel singularities. A numerical application to πN-πN forward dispersion relations is considered. (auth)

**7523** PION AS A REGGE POLE. M. M. Islam (Brown Univ., Providence). Nuovo Cimento (10), 30: 579-86(Oct. 16, 1963). (TID-18756)

It was previously pointed out by Ferrari and Selleri that the single-pion production in N-N collision in the 1 to 3 Bev range can be well explained by the one-pion exchange model (OPEM), if one introduces an unknown function of momentum transfer. The function is determined empirically by them. Such a function of momentum transfer is allowed by field theory where the pion is treated as an elementary particle. It is shown that if the pion is reggeized following present conjectures, then a similar function, but also dependent on energy, occurs in OPEM. In the 1 to 3 Bev range it is found that the energy dependence of this function is small and that it agrees well with the empirical function of FS. It is also shown that the pion reggeized in this way does not change the Treiman-Yang test. (auth)

**7524** EIGHTFOLD WAY AND WEAK INTERACTIONS. M. Gourdin (Laboratoire de Physique Théorique, Orsay, France). Nuovo Cimento (10), 30: 587-602(Oct. 16, 1963).

The octet model is generalized in a manner that permits the experimentally observed conservation rules ($|\Delta S| = 1$, $|\Delta I| = 3/2$) to be reproduced. It is shown that the most simple solution of this problem is an orthogonal symmetry based on the group SO(8), the baryons being described in an irreducible representation of dimension 8. The Yukawa meson–baryon coupling and the meson and baryon currents are studied and classified. (auth)

**7525** A PHENOMENOLOGICAL STUDY OF VERY-HIGH ENERGY COLLISIONS. ANGULAR DISTRIBUTION OF SECONDARIES IN JETS. O. Czyżewski and A. Krzywicki (CERN, Geneva). Nuovo Cimento (10), 30: 603-21 (Oct. 16, 1963).

The experimental data on angular distributions of secondaries in jets are examined from the point of view of a model being an idealization of multiperipheral models. It is assumed that pionization secondaries are emitted independently from each other but with small transverse momenta and small average inelasticity, as required by peripherality. This leads to a quasirectangular distribution of the log tg $\theta$ variable. The statistical properties of this distribution are studied using the Monte Carlo method. A semiquantitative analysis shows that the model explains the main features of quasielementary collisions ($N_h \leq 5$, $n_s \leq 20$) in the energy region $10^{12}$ to $10^{14}$ ev, in particular the existence of the two-center events. (auth)

**7526** INNER BREMSSTRAHLUNG IN ISOVECTOR VECTOR MESON DECAYS. S. Iwao (Università, Genoa and Istituto Nazionale di Fisica Nucleare, Genoa). Nuovo Cimento (10), 30: 656-65(Oct. 16, 1963).

Inner bremsstrahlung in $\rho$-meson decay is calculated. The energy spectrum of the pion as well as the branching probability are given. A possibility for determining the validity of the Gell-Mann, Sharp, and Wagner model for the three-body photonic decay is discussed. A vector form factor of the four-field vertex is treated by a subtracted dispersion relation. If there exists a J = 1 two-pion resonance besides $\rho$-meson, it will also contribute to the form factor. The $\rho$-meson contribution is treated as a sharp resonance that gives an infrared shape to the form factor. A correction from this term to the pion spectrum as well as to the branching probability is estimated. (auth)

**7527** NOTE ON A CRUDE NUCLEON-NUCLEON POTENTIAL. F. Coester (Argonne National Lab., Ill.) and E. Yen. Nuovo Cimento (10), 30: 674-6(Oct. 16, 1963).

Spin-dependent central Serber potentials are considered and fit to the neutron-proton scattering lengths and effective ranges. The high-energy p-p singlet phase shifts for s and d waves were calculated. (R.E.U.)

**7528** RESONANCE METHOD IN SCATTERING THEORY. Egil A. Hylleraas (Univ. of Oslo). Phys. Math. Univ. Oslo Inst. Rept., No. 18, 21p.(1963). (ARL-63-215)

An indirect method is presented for analyzing scattering by a potential. In the method, the potential strength is taken as a variable and the momentum is held constant at a value corresponding to a negative energy level. Only S-wave scattering is considered. (T.F.H.)

**7529** $\Lambda$-NUCLEON INTERACTIONS AT LOW AND INTERMEDIATE ENERGIES. Budh Ram and B. W. Downs (Univ. of Colorado, Boulder). Phys. Rev., 133: B420-8 (Jan. 27, 1964).

The low-energy $\Lambda$-nucleon interaction was represented by several effective central potentials that have a hard core of radius 0.4 F and four-parameter attractive wells with an interaction for large separations suggested by the two-pion-exchange mechanism. These potentials, which are consistent with the binding-energy data for the light hypernuclei, were taken to represent the $\Lambda$-nucleon interaction in even-parity states for energies greater than those that play a role in the binding of the light hypernuclei. These potentials and others of reduced strength were taken to represent the interaction in odd-parity states. The binding energy D of a $\Lambda$ particle in nuclear matter and $\Lambda$-nucleon scattering cross sections were calculated with these potentials. The calculated cross sections and empirical cross sections for energies less than 76 Mev in the zero-momentum frame are in agreement only if the interaction of odd-parity states is taken to be (approximately) as strong as that in even-parity states. These effective central potentials of equal strength in even-parity and odd-parity states lead to values of D close to 40 Mev. (auth)

**7530** SPIN AND PARITY ANALYSIS AT ALL PRODUCTION ANGLES. Murray Peshkin (Argonne National Lab., Ill.). Phys. Rev., 133: B428-30(Jan. 27, 1964).

Bohr's symmetry method is applied to an unstable spin-j state X, which is produced in a reaction A + B → C + X and then decays according to X → D + E. Particles A, B, C, D are assumed to be spinless, and E is either a spinless particle or a gamma ray. Parity is conserved in production, but not necessarily in decay. The angular distribution of E, in the rest system of X, is $I(\theta) = \frac{1}{2}\Sigma a_L P_L(\cos\theta)$, where $L \leq 2j$ and the polar angle $\theta$ is measured from the normal to the production plane. The coefficients $a_L$ depend upon the production angle $\delta$ and upon the dynamics of the production. It is proved here that the sign of the maximum-complexity coefficient $a_{2j}$ depends only upon the parity of X, and that the magnitude of $a_{2j}$ is not zero but lies between bounds that depend upon j and the parity alone. The implied test for j and the parity has the advantages: The spin j is equal to half the largest L in $I(\theta)$. Addition of a small amount of a higher $P_L$, which always improves the fit, is forbidden by the lower bound of $a_{2j}$. The bounds of $a_{2j}$ are independent of $\delta$. Any (perhaps biased) average over $\delta$ may be performed before expanding $I(\theta)$ in the $P_L$. All the data are condensed into a single test quantity $a_{2j}$, whose statistical error is reliably known. (auth)

**7531** ANNIHILATION PRODUCTION $p + \bar{p} \rightarrow \Lambda + \bar{\Lambda}$. C. H. Chan (Middle East Technical Univ., Ankara). Phys. Rev., 133: B431-9(Jan. 27, 1964).

The reaction $p + \bar{p} \rightarrow \Lambda + \bar{\Lambda}$ is considered in full detail with the assumption that the process is dominated by the exchange of a $K^*$. Both the cases of an elementary and of a Regge-pole $K^*$ are discussed. Results on differential cross section, polarization functions, and angular correlation functions with various combinations of longitudinal and transverse polarizations of $\Lambda$ and $\bar{\Lambda}$ are presented. These values can be checked easily in a bubble chamber experiment. It is found that from the differential cross section alone it is impossible to distinguish one type of $K^*$ from the other, but a measurement of the angular correlations may give deciding information. (auth)

**7532** INELASTIC $\pi^+\pi^-$, $K^0\bar{K}^0$, AND $K^+K^-$ COLLISIONS IN UNITARY SYMMETRY. W. W. Wada (Northwestern Univ., Evanston, Ill.). Phys. Rev., 133: B439-43 (Jan. 27, 1964).

The G conjugation invariance in the isospin representation and its analogs in the u-spin and v-spin representations of unitary symmetry are applied to the inelastic channels of reactions initiated in the $\pi^+\pi^-$, $K^0\bar{K}^0$, and $K^+K^-$ systems. Relations among differential cross sections for various particle-antiparticle pairs are obtained with and without R invariance.

**7533** POLARIZATION EFFECTS IN THE PRODUCTION OF INTERMEDIATE BOSONS. H. Ueberall (Univ. of Michigan, Ann Arbor). Phys. Rev., 133: B444-53(Jan. 27, 1964).

For the coherent production of intermediate bosons by neutrinos or muons in the Coulomb field of nuclei, total cross sections, angular distributions, and spectra of the leptons appearing in the production reaction, and in particular polarization effects, e.g., the components of the polarization vector of the boson as a function of production angle and energy, and the angular distributions of charged

leptons from decay in flight, which are characterized by the strong circular polarization of the boson, are evaluated. The angular distributions of $2\pi$ decay are obtained also. In the calculation, the Weizsäcker-Williams method is used in covariant form, to demonstrate that this convenient calculatory shortcut lends itself perfectly to the evaluation of polarization effects. (auth)

**7534** POSSIBLE EFFECTS OF STRONG INTERACTIONS IN THE FEINBERG-PAIS THEORY OF WEAK INTERACTIONS. Ngee-pong Chang (Columbia Univ., New York). Phys. Rev., 133: B454-6(Jan. 27, 1964).

It is shown that, in the simplest model where strong interaction effects are included in the baryon vertices and propagators only, the peratization of the nuclear vector $\beta$-decay coupling strength is no longer equal to the corresponding peratization of the $\mu$-decay coupling strength. This might suggest a vastly different role of strong interactions in the weak interaction (peratization) theory of Feinberg and Pais, in order to conform with the observed equality of nuclear vector $\beta$-decay and $\mu$-decay strengths. (auth)

**7535** AVERAGE Λ-NUCLEON INTERACTION IN THE HYPERTRITON. D. R. Smith (U. S. Air Force Academy, Colo.) and B. W. Downs (Univ. of Colorado, Boulder). Phys. Rev., 133: B461-5(Jan. 27, 1964).

Upper bounds on the strength of the average Λ-nucleon interaction required to account for the observed binding of the hypertriton were established in a variation calculation with a ten-parameter trial function. Central two-body potentials having hard-core radii 0.2, 0.4, and 0.6 F and ranges suggested by consideration of the two-pion-exchange mechanism were used. These calculations led to improvements of 3–6% (depending upon the hard-core radius) in the required strengths over the results of previous calculations with a four-parameter function. The results cannot be used to rule out the existence of a bound hyperdeuteron of spin 0 for a hard-core radius as large as 0.6 F. A partial variation calculation is described, in which only two of the ten parameters of the trial function are varied. When the remaining parameters are fixed by consideration of the two-body subsystems of which the hypertriton is composed, variation of two appropriate parameters leads to required strengths within 3% of the values obtained by varying all ten parameters. (auth)

**7536** A DYNAMICAL CALCULATION OF THE $\eta \to 3\pi$ DECAY RATE. Barbara Barrett (Columbia Univ., New York) and G. Barton. Phys. Rev., 133: B466-74 (Jan. 27, 1964).

Dispersion relations for calculating the strength of the virtual $\eta \to \pi^0$ transition are formulated, and contributions from all possible intermediate baryon-antibaryon states are included. In the approximation, the change in isospin is derived from the baryon electromagnetic mass splittings, other contributory causes being neglected. The $\eta \to 3\pi$ decay rate is governed by the strength of this transition if, as is believed, the decay proceeds via virtual single pseudoscalar boson intermediate states. The contributions from the two sequences $\eta \to (\pi^0) \to \pi^+ + \pi^- + \pi^0$ and $\eta \to \pi^+ + \pi^- + (\eta) \to \pi^+ + \pi^- + \pi^0$ cancel each other exactly if the eightfold way interaction $4\pi\lambda(\pi \cdot \pi + \eta\eta)^2$ is used, and if the strength of the $\eta - \pi^0$ transition is taken to be independent of which particle is on its mass shell. Here this difficulty is resolved since the dynamical calculation allows for the mass dependence of the $\eta - \pi^0$ black box. Comparison of the provisionally evaluated result with that of a previous calculation on $\eta \to 2\gamma$ gives an estimate for the $\eta \to 2\gamma/\eta \to \pi^+\pi^-\pi^0$ branching ratio that is in satisfactory agreement with experiment. (auth)

**7537** ELECTROMAGNETIC AND DECAY PROPERTIES OF $G_2$ MULTIPLETS. A. J. MacFarlane, N. Mukunda, and E. C. G. Sudarshan (Univ. of Rochester, N. Y.). Phys. Rev., 133: B475-77(Jan. 27, 1964).

Consequences of exact and approximate invariance under the group $G_2$ are presented for baryons, mesons, and resonances. The method of Weyl reflections and the Shmushkevich algorithm, previously applied to the group $SU_3$, are used to derive electromagnetic mass and magnetic moment relations, and also relations between the one- to two-particle decay vertices (coupling constants). The assignment of multiplets is the usual one, using the singlet, the 7-fold, and the 14-fold representations of $G_2$. (auth)

**7538** A FIELD THEORY OF WEAK INTERACTIONS. [PART] II. G. Feinberg (Columbia Univ., New York) and A. Pais. Phys. Rev., 133: B477-86(Jan. 27, 1964).

The study of the Bethe-Salpeter equation for lepton-lepton interaction mediated by charged vector mesons is continued. Starting from the exact integral equation, an improved approximation procedure is developed. This reproduces the low-energy results for allowed processes given previously. Beyond that, it is now found that to leading order the BS equation gives the value $3g^2/4\pi^2$ for the zero-energy ratio between forbidden and allowed amplitudes, where g is the bare meson-lepton coupling constant. Information on the momentum dependence of the forbidden amplitude is also obtained. The mathematical methods developed earlier are then applied to the corresponding Bethe-Salpeter equation of the Fermi field theory. It is shown that the calculated amplitudes for both allowed and forbidden processes are equal to zero. This illustrates the fact that if higher order effects are taken seriously, there is no reason to consider the Fermi field theory as the limiting case of a vector meson theory with a boson mass that tends to infinity. (auth)

**7539** HAMILTONIAN MODEL OF LORENTZ INVARIANT PARTICLE INTERACTIONS. T. F. Jordan, A. J. MacFarlane, and E. C. G. Sudarshan (Univ. of Rochester, N. Y.). Phys. Rev., 133: B487-96(Jan. 27, 1964). (NYO-10275)

A model is constructed of interaction in a quantum mechanical system of two spinless particles. The interaction is shown to produce nontrivial scattering. Lorentz symmetry of the model is established by the construction of generators of a unitary representation of the inhomogeneous Lorentz group. The total momentum and angular momentum operators are the same as for a system of two free particles. This ensures familiar transformation properties under space translations and space rotations. The hamiltonian satisfies the asymptotic condition relative to the hamiltonian for a system of free particles. The use of the asymptotic condition is shown to be Lorentz invariant. The scattering amplitude is a manifestly invariant function of the particle momentum variables, and can be made to have a variety of analyticity properties by a suitable choice of the arbitrary form factors that occur in the model. (auth)

**7540** EXCITED STATES OF THE NUCLEON. P. Carruthers (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 133: B497-514(Jan. 27, 1964).

The quantum numbers of the higher resonances in pion-nucleon scattering belonging to the nucleon and 3–3 isobar trajectories are shown to arise from the exchange of the nucleon and pion-nucleon resonances themselves. In par-

ticular the members of the nucleon trajectory are created principally by forces due to the exchange of members of the 3–3 isobar trajectory and vice versa. The quantum numbers obtained from dynamical considerations agree completely with those conjectured on the basis of Regge pole considerations. The dynamical scheme is approximately symmetrical under interchange of the two trajectories. (auth)

**7541** EFFECT OF THE BARYON EXCITED STATES ON THE N–Λ AND Λ–Λ FORCES. Y. Nogami and F. J. Bloore (National Research Council, Ottawa). Phys. Rev., 133: B514-21(Jan. 27, 1964).

The N-Λ and Λ-Λ potentials caused by the exchange of two pions are calculated in the static theory, taking into account the resonance $Y_1^*$ in the π-Λ system and the (3–3) resonance in the π-N system. The recoil of the baryons is included in an approximate way. It is shown that the presence of these resonances diminishes the spin-dependent part of the central potential and the tensor potential, and increases the spin-independent part of the central potential. The triplet potential turns out to be slightly stronger than the singlet potential at large distances, and slightly weaker than closer in. If the resonances are omitted, the triplet potential is the stronger over the whole range. This last result is in mild disagreement with other work. Its relation to the choice of a one-channel or two-channel formalism is discussed. (auth)

**7542** THE PRESENT STATE OF THE INVESTIGATION OF NEUTRINO INTERACTIONS. Andrzej Eskreys (Inst. of Nuclear Research, Polish Academy of Sciences, Krakow). Postepy Fiz., 14: 435-54(1963). (In Polish)

The present state of theories of neutrinos and experimental analyses of the interaction of neutrinos with matter are discussed. It was observed that the results of experiments carried out to date relate to two general problems: the nature of the neutrino as an elementary particle and the agreement of the predictions of theories of weak interactions with experimental evidence. Data indicate that there exists four different neutral particles of spin ½ and rest mass equal to or very near zero; the electron neutrino and antineutrino, and the meson neutrino and antineutrino. They are identified by their origin. The neutrino and antineutrino in both cases differ in polarization (spin direction). No difference was found between the interaction of the electron neutrino (or antineutrino) or the meson neutrino (or antineutrino) with matter. No disagreement between experiment and the predictions of the universal theory of weak interactions was observed in the laboratory up to neutrino energies of about 500 Mev. (TTT)

**7543** THE GENERAL SOLUTION OF THE LOW EQUATION FOR KΛ-SCATTERING. R. W. Lardner (Columbia Univ., New York). Proc. Cambridge Phil. Soc., 59: 775-7(Oct. 1963).

A derivation is given of the general solution of the static baryon Low equation for K-Λ scattering. This model was previously used to indicate possible ambiguities in the terms elementary and bound-state as applied to particles. The solution can be used to establish this result from a general viewpoint that may possibly be applicable to more realistic models. (auth)

**7544** EXACT SOLUTION OF RELATIVISTIC EQUATIONS OF MOTION OF AN ELECTRON IN AN EXTERNAL RADIATION FIELD. Vachaspati. Proc. Natl. Inst. Sci. India, Pt. A, 29: 138-42(Mar. 26, 1963).

The equations of motion of an electron in an external monochromatic radiation field are solved exactly. The solutions are quite elegant and involve only the first two harmonics of the incident frequency. The results of Vachaspati and Punhani are firmly established. (auth)

**7545** ON THE THRESHOLD BRANCH-POINT OF MANY-BODY CHANNELS. T. F. Tuan (Univ. of Birmingham, Eng.). Proc. Roy. Soc. (London), Ser. A, 276: 492-501(Dec. 17, 1963).

The analytic behavior of the elastic and break-up scattering amplitudes in a soluble one-dimensional model was examined by Nussenzveig. It was found that the break-up threshold gave rise to rather curious cube-root branch-points in the scattering amplitude. The scattering amplitude in a soluble model that reduces Nussenzveig's model to the special case where the incident and ionized particles have equal masses is examined. It is shown that the threshold branch-point is a function of the ratio of the masses of the two particles and that the cube-root occurs only when the masses are equal. In general, there are an infinite number of Riemann sheets associated with the threshold branch-point. An examination into the physical origin of such a threshold behavior is also made to determine if a more complicated branch-point than a simple square-root may exist for a more realistic potential model. (auth)

**7546** CLUSTER EXPANSIONS AND THE THEORY OF MANY-BOSON SYSTEMS. V. H. Smith, Jr. and H. A. Gersch (Georgia Inst. of Tech., Atlanta). Progr. Theoret. Phys. (Kyoto), 30: 421-34(Oct. 1963).

The previous configuration-space cluster integral treatment of the properties of the ground state of a many-boson system is modified by including those higher order diagrams consistent with the pair excitation approximation, which were previously omitted. The cluster expansions involve a parameter, analogous to the fugacity in classical expansions, whose definition automatically accounts for the depletion of the free particle ground state. The resulting expectation value for the hamiltonian is in agreement with that obtained by field-theoretic methods for states of pair-excitation type. (auth)

**7547** NON-LINEAR INTEGRAL EQUATIONS OF THE HAMMERSTEIN TYPE. Masanao Kitamura (International Christian Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 30: 435-42(Oct. 1963).

The integral equations studied recently by Bardeen, Cooper, and Schrieffer and many others in connection with many-body problems are studied in rather general form. They are the nonlinear integral equations of the kind studied by Hammerstein. Some of his results can be applied in their original form to the study of Bardeen-Cooper-Schrieffer equation, (BCS equation). However, BCS equation is so singular that the usual proof of the convergence of the successive approximation can not be applied in this case. It is shown here that with a slight but important modification the convergence of the successive approximation can be assured provided BCS equation satisfies certain conditions. (auth)

**7548** PHASE SHIFT ANALYSIS OF PROTON-PROTON SCATTERING AT 52 Mev AND SPIN-ORBIT FORCE. Norio Hoshizaki (Kyoto Univ.), Shoichiro Otsuki, Ryozo Tamagaki, and Wataro Watari. Progr. Theoret. Phys. (Kyoto), 30: 494-504(Oct. 1963).

A phase shift analysis of p-p differential cross section, polarization and $C_{KP}$ measurements at 52 Mev is performed in terms of six parameters. Partial waves with $L \geq 3$ are assumed to be correctly represented by the one-pion-exchange contribution with $g^2/4\pi = 14.4$. The

phase shift solution thus obtained is consistent with those at 68.3 and 98 Mev. The solution together with those at 68.3 and 98 Mev seems to indicate that the effect of the spin-orbit force is not so strong below 100 Mev as at 310 Mev. This point is discussed in some detail. (auth)

**7549** (3/2, 3/2) RESONANCE EFFECT IN THE REACTION $\pi + N \rightarrow N + 2\pi$. TWO-PION-EXCHANGE PROCESS. Kiyomi Itabashi (Tokyo Univ.) and Takeshi Ebata. Progr. Theoret. Phys. (Kyoto), 30: 505-20 (Oct. 1963).

The process $\pi + N \rightarrow N^*(3/2, 3/2) + \pi$ caused by the exchange of $2\pi$ system T = J = 1 is investigated. Within a pretty good approximation, the desired reaction amplitude can be obtained by making use of the dispersion theory of single pion production by a virtual photon. The theory involves only one adjustable parameter, the $\pi$-$\pi$ coupling constant $\lambda$. As an example, the theory is compared with the Stonehill-Kraybill data for the small $\Delta^2$ events of $\pi^+p \rightarrow p\pi^+\pi^0$ at 1.26 Bev ($\Delta^2$ being the nucleon four-momentum transfer squared). The shape of experimental Q-value spectrum of final $(p,\pi^+)$ pair can be reproduced fairly well by taking into account both of the one-pion exchange (OPE) and our N*-production processes with a reasonable choice of the value of the parameter $\lambda$. From this result it is concluded that, even in the relatively small $\Delta^2$ region, the N* effect can be comparable to the OPE contribution, against the conventional simplified supposition of predominance of the latter in this region. Finally a possibility is suggested that the value of the parameter $\lambda$ be determined more definitely from the more precise measurements of the reaction. (auth)

**7550** DIAGONALIZATION OF THE PARTICLE MIXTURE INTERACTION. Takao Kaneko, Yoshio Ohnuki, and Keiji Watanabe (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 30: 521-35(Oct. 1963).

The diagonalization problem is discussed when there exists a particle mixture interaction. It is shown that the propagators can be diagonalized in such a way that the transformed one has a single pole. Then the connection with the renormalization is discussed. When the propagators have an unstable pole, the diagonalization matrix becomes complex and the asymptotic field corresponding to the stable particle pole cannot be constructed in Yang-Feldmann's sense. The method is applied in calculating $\Lambda \rightarrow N + \pi$ decay. (auth)

**7551** ON THE VIOLATION OF THE FULL SYMMETRY IN LEPTONIC DECAYS OF BARYONS AND MESONS. Mineo Ikeda and Takayoshi Maekawa (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto), 30: 536-44(Oct. 1963).

The leptonic decays of baryons and mesons are investigated with particular attention to the violation of the full symmetry in the Sakata model. It is assumed that the weak interactions causing such decays break the equality between neutron and $\Lambda$-particle in a certain systematic way. The $\Delta Q = -\Delta S$ leptonic decays can be treated and results consistent with the recent experiments are obtained, while the T-invariance is broken to some extent. The $\pi^{0\prime}$ meson is found to have little effect on the spectrum in the $K_{e3}$ and $\pi_{e3}$ decays. The existence of two kinds of neutrinos may be understood if a restricted symmetry between basic particles and leptons is assumed. (auth)

**7552** A STRUCTURAL MODEL FOR POSITRONS. Pratul Bandyopadhayay (Indian Statistical Inst., Calcutta). Progr. Theoret. Phys. (Kyoto), 30: 563-5(Oct. 1963).

The non-local electromagnetic interaction lagrangian for the origin of the electronic mass is modified for the case of the positron. A two-component spinor with internal freedom is substituted for a four-component spinor in such a way that two sets of two-component spinors, representing electrons and positrons can be constructed. Extending the theory of the origin of the electronic mass, it is assumed that the mass of a positron is also due to the nonlocal interaction of the electromagnetic field with a bare positron of mass zero. (C.E.S.)

**7553** VALIDITY OF $\Delta Q = \Delta s$ RULE IN THE LEPTONIC DECAYS OF STRANGE PARTICLES. Yasuhisa Katayama (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 30: 567-9(Oct. 1963).

An interpretation of the invalidity of the $\Delta Q = \Delta s$ rule in meson ($K_{e3}$) and hyperon ($\Sigma_{ne}$) decays, and its validity in meson ($K_{e4}$) decay is presented. (C.E.S.)

**7554** (3,3)-RESONANCE AND ENERGY DEPENDENCE OF A NORMAL SPIN-CORRELATION COEFFICIENT IN p-p SCATTERING. Norio Hoshizaki (Kyoto Univ.) and Shigeru Machida. Progr. Theoret. Phys. (Kyoto), 30: 575-6(Oct. 1963).

The energy dependence of the normal spin-correlation coefficient $C_{nn}(90°)$ in p-p scattering is analyzed to investigate the proposal that the large value of the coefficient at 660 Mev can be interpreted as an effect of the formation of a (3,3)-resonance in the meson ($\pi$) production processes. (C.E.S.)

**7555** ON THE POSSIBILITY OF ONE NEUTRINO. Yukio Ito (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 30: 581-3(Oct. 1963).

It is shown that high-energy neutrino-nucleon collision experiments that seem to support the existence of two kinds of neutrinos can be explained by a one neutrino hypothesis. (C.E.S.)

**7556** DETERMINATION OF PION-NUCLEON PARAMETERS AND PHASE SHIFTS BY DISPERSION RELATIONS. J. Hamilton (Univ. of London) and W. S. Woolcock. Rev. Mod. Phys., 35: 737-87(Oct. 1963).

The application of single variable dispersion relations to calculate the main parameters of low-energy $\pi$-N interactions and the low-energy phase shifts is discussed. Data on the total cross sections and the dominant resonances of the $\pi$-N system are also given. Numerical values of the parameters and phase shifts are presented. (C.E.S.)

**7557** INTERPOLATIVE FORMULAS FOR PION-NUCLEON SCATTERING PHASE SHIFTS. John M. McKinley (Kansas State Univ., Manhattan). Rev. Mod. Phys., 35: 788-94(Oct. 1963).

Interpolative expressions for the phase shifts in $\pi$-N interactions in the energy range up to 600 Mev are considered. Each s- and p-wave phase shift is treated individually. The Fermi-type phase shifts found in individual experiments at various energies were taken as the points to be fitted by the interpolative expressions. Polynomial fits with two, three, and six parameters were calculated by a least squares fitting program for the dominant (3,3) phase shift. To indicate the behavior of the phase shift expressions that were obtained, the real parts of the forward scattering amplitudes were calculated and compared with the results of dispersion relation evaluations. (C.E.S.)

**7558** THE OCTET MODEL AND ITS CLEBSCH-GORDAN COEFFICIENTS. J. J. de Swart (CERN, Geneva). Rev. Mod. Phys., 35: 916-39(Oct. 1963).

The Clebsch-Gordan (CG) coefficients of SU(3) are derived for the products of the most important irreducible

representations. Useful symmetry relations for the CG coefficients are derived. The Wigner-Eckart theorem for this group is given and applied to derive a general mass formula for the octets. The Gell-Mann-Okubo mass relation and a mass relation for the octets that is very well satisfied by the vector mesons, if one takes as the K* the 730-Mev (K-π) resonance, are given. The Yukawa couplings between baryons and mesons are considered. The mathematical framework of the octet model for strong interactions is examined. (C.E.S.)

**7559** RECENT ADVANCES IN SCIENCE. PHYSICS. THE PROPERTIES OF THE MUON. S. Devons (Columbia Univ., New York). Sci. Progr. (London), 51: 249-59 (Apr. 1963).

The electromagnetic properties of μ mesons are discussed. Their role in weak interactions and their similarity to electrons are also discussed. (R.E.U.)

**7560** $\bar{K}$-NUCLEON INTERACTIONS. Ramesh Chand (Syracuse Univ., N. Y.). 15p. (CONF-340-2)

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Total scattering and absorption cross sections for $\bar{K}$-nucleon collisions in I = 1, $p_{\frac{1}{2}}$-channel are given as functions of the two sets of energy-dependent $\bar{K}N$ scattering parameters solutions. These scattering parameters are obtained by linear interpolations between Watson's amplitudes around 400 Mev/c and the amplitude at the position of the pole in the $\bar{K}N$ scattering amplitude corresponding to the $p_{\frac{1}{2}}$-wave 1385-Mev $Y_1^*$ resonance with 50-Mev width. The zero-range expansion for p-wave $\bar{K}$-nucleon phase shift and the scattering parameters of Watson's solution are found to be in violation of the requirements of causality and of positive definiteness of transition probabilities. (auth)

## Field Theory and Quantum Mechanics

**7561** (NP-13471) COMPUTER PROGRAM FOR SOLVING EQUATIONS OF MOTION OF CHARGED PARTICLES IN ELECTROMAGNETIC FIELDS. Irwin M. Miller (Johns Hopkins Univ., Silver Spring, Md. Applied Physics Lab.). Nov. 10, 1961. 132p. (CF-2952)

A computer program, in FORTRAN for the IBM-7090, is described for the integration of the equations of motion of a charged particle in various electric and magnetic fields, as well as the computation of various quantities, such as the magnetic moment, angular momentum, etc., from the resulting trajectories. Flow charts, mathematical formulas and techniques, and the program listing are included. (auth)

**7562** (JPRS-21869(p.1-82)) INDUCED AND SPONTANEOUS EMISSION. V. M. Fayn. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 6: 207-41(1963).

Classical and quantum analyses of induced and spontaneous emissions are given. The establishment of the correspondence principle, emissions in a system whose levels form a continuous spectrum, and the history of emissions in free space are discussed. Radiation in a resonator is discussed. (R.E.U.)

**7563** A NEW METHOD FOR FINDING THE PHASE SHIFTS FOR THE SCHRÖDINGER EQUATION. T. Tietz (Univ. of Lodz, Poland). Acta Phys. Acad. Sci. Hung., 16: 289-92(1963).

A formula for finding the phase shift of the Schrödinger equation is derived. The formula is used to calculate phase shifts for a Thomas-Fermi potential. (C.E.S.)

**7564** PARTICLES AND FIELDS. B. Schroer (Universität, Hamburg). Acta Phys. Austriaca, 17: 72-84(1963).

The relation of the concept of particles with the concept of fields is discussed. Postulates in the concept of particles and fields are listed. It is shown why in contrast to potential theory, relativistic local field theory treats all particles on the same footing. (M.C.G.)

**7565** ON THE ASYMPTOTIC CONDITION IN A LOCAL RELATIVISTIC QUANTUM FIELD THEORY. Klaus Hepp (Eidgenössische Technische Hochschule, Zurich). Acta Phys. Austriaca, 17: 85-95(1963).

It is shown how asymptotic free-particle states and a scattering matrix can be constructed in the axiomatic framework of Wightman. The Haag-Ruelle strong convergence asymptotic condition is discussed. Reduction formulas are given for the 2-particle scattering amplitude. (M.C.G.)

**7566** ON DISTRIBUTION CALCULATIONS IN GRAVITATIONAL THEORY. Dieter Robaschik (Karl Marx Universität, Leipzig). Acta Phys. Polon., 24: 299-311(Sept. 1963). (In Polish)

The Einstein field equations were investigated in a first approximation. An optionally suggested metric was used as a zero approximation. With the help of a coordinate restriction, these equations were brought into a simple form and statements were made concerning the Green functions of these equations. The applicability of this approximation method is considered. (tr-auth)

**7567** A DIFFERENCE BETWEEN THE TWO APPROXIMATION METHODS IN GENERAL RELATIVITY. Adolf Kuehnel (Leipzig Univ.). Acta Phys. Polon., 24: 399-405(Sept. 1963).

The two approximation methods in general relativity, the EIH-method and the fast motion approximation, are compared in the lowest orders. In the linear approximation the equations of the EIH-method may be derived from those of the linear fast motion approximation. In higher orders the equations of the EIH-method can not be obtained from those of the fast motion approximation. (auth)

**7568** THE PROPERTIES OF THE HELIUM ATOM AND THE TWO-ELECTRON SYSTEMS. A. L. Stewart (Queen's Univ., Belfast). Advan. Phys., 12: 299-353 (July 1963).

Theoretical work in the past few years on the properties of two-electron systems is reviewed. The Schroedinger equations are given with relativistic corrections, and solutions in the nonrelativistic form. Values of the mass polarization and relativistic and radiative energy corrections are investigated perturbatively. The diamagnetic susceptibilities and nuclear magnetic shielding constants, electric field polarizability, and oscillator strength are discussed. 102 references. (R.E.U.)

**7569** UNITARY OPERATOR FORMALISM OF THE EIGENVALUE PROBLEMS. Joseph C. Y. Chen (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 39: 3167-70 (Dec. 15, 1963). (BNL-7251)

Utilization of the parameters involved in the system under consideration leads to a unitary operator formalism for dealing with eigenvalue problems. The existence of a unitary linear operator that transfers a known function, being predetermined for a special choice of the parameter, to the general eigenfunction is demonstrated and its properties are discussed. The related hypervirial theorems for variational Hellmann-Feynman wavefunction are discussed. The scaling problem and virial theorem are treated in some detail by means of the unitary operator techniques. (auth)

**7570** VON NEUMANN ALGEBRAS OF LOCAL OBSERVABLES FOR FREE SCALAR FIELD. Huzihiro Araki (Univ. of Illinois, Urbana). J. Math. Phys. (N. Y.), 5: 1-13(Jan. 1964).

Basic properties of von Neumann algebras of local observables for the free scalar field are investigated. In particular, the duality theorem for regions at a fixed time is proved. It is also shown that von Neumann algebras for regions at a fixed time are factors of type $II_\infty$ or $III_\infty$. An argument, which excludes the possibility of a factor of type I for a general class of theory and for a certain class of regions, is given. (auth)

**7571** POSITION AND POLARIZATION OPERATORS IN RELATIVISTIC AND NONRELATIVISTIC MECHANICS. H. Bacry (Université, Marseille). J. Math. Phys. (N. Y.), 5: 109-11(Jan. 1964).

It is shown how the position operator and the polarization operator are obtained in non-relativistic quantum mechanics from their equivalents in relativistic quantum mechanics. This problem is investigated with the aid of group methods; it is furthermore shown that the two operators cannot be studied separately. (auth)

**7572** MOTION OF TEST BODIES IN GENERAL RELATIVITY. A. H. Taub (Univ. of Illinois, Urbana and Inst. for Advanced Study, Princeton, N. J.). J. Math. Phys. (N. Y.), 5: 112-19(Jan. 1964).

Two distributions in the sense of Schwartz are introduced to describe a test body. Papapetrou's equations for a pole–dipole test body are derived in a coordinate-independent manner. The supplementary condition $S^{\alpha\beta}U_\mu = 0$ arises in a natural fashion in the course of the derivation. The method for treating test bodies with higher-order poles is indicated. (auth)

**7573** REGGE FIELDS. A. L. Licht (Naval Ordnance Lab., Silver Spring, Md. and Univ. of Maryland, College Park). Nuovo Cimento (10), 30: 117-33(Oct. 1, 1963).

The following nonrelativistic systems are second quantized. The rigid boson rotator, both interacting and free, the rigid non-interacting fermion rotator, the spherical harmonic oscillator, and the hydrogenlike atom. In each case a field operator is found whose propagator exhibits Regge pole behavior. (auth)

**7574** "AMBIGUITY" OF HARMONIC-OSCILLATOR COMMUTATION RELATIONS. D. G. Boulware and S. Deser (CERN, Geneva). Nuovo Cimento (10), 30: 230-4(Oct. 1, 1963).

The possibility that the form of the hamiltonian together with the Heisenberg equations do not imply canonical commutation relations for the harmonic oscillator variables, is re-examined. It is shown that this freedom of commutation relations just expresses the known possibility of quantizing the system by Bose or Fermi (and para-Fermi) statistics, and of altering the zero-point energy. (auth)

**7575** SOME MYRIOTIC PARABOSON FIELDS. A. Galindo (CERN, Geneva). Nuovo Cimento (10), 30: 235-9(Oct. 1, 1963).

A continuous infinity of inequivalent irreducible representations is given for the paraboson commutation relations of multiplicity two. All these representations but the standard one are myriotic, i.e., there exists no normalizable vacuum state and the total particle number operator is defined nowhere in the manifold of state vectors. (auth)

**7576** QUANTUM VARIABLES AND GROUP PARAMETERS. J. Schwinger (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). Nuovo Cimento (10), 30: 278-91(Oct. 1, 1963).

Mathematical and physical difficulties in the usual treatments of field theories that admit infinite-dimensional transformation groups are overcome by combining the physical operator variables with the mathematical group parameters. There is also a discussion, for non-Abelian gauge theories, of the limited, asymptotic, physical significance of total internal properties, and a derivation of the energy-density commutator condition. (auth)

**7577** ON THE FOUNDATIONS OF RELATIVISTIC ENERGY MECHANICS. D. G. B. Edelen (RAND Corp., Santa Monica, Calif.). Nuovo Cimento (10), 30: 292-320 (Oct. 1, 1963).

The Einstein theory of general relativity is shown to yield a general mechanics of continuous media under the assumption that the momentum-energy tensor admits a unique timelike eigenvector. Physical interpretations of the governing equations are derived, together with constitutive relations for general and isotropic materials. It turns out that the mechanics can always be viewed as describing the flow of rest-energy. Invariant requirements for the existence of a stress potential are obtained, the satisfaction of which leads to a decomposition and partial evaluation of the rest-energy. The Einstein field equations are shown to imply the existence and uniqueness of an intrinsic energy density for any material medium (intrinsic immutable mass). The usual procedure of adding conditions to the Einstein theory in order to obtain an analogous intrinsic quantity is thus unnecessary. The path density, which defines the intrinsic energy, is shown to be path-independent in an appropriate sense if the stresses admit a stress potential. This suggests a decomposition of the generalized stresses and leads to a fundamental differential relation on the trajectories of the energy flux. Natural definitions of intrinsic temperature and intrinsic entropy-density are direct consequences of the fundamental differential relation and lead to generalized thermodynamic descriptions that include the effects of gravitational radiation. (auth)

**7578** RELATIVISTIC SCALAR PRODUCTS OF $\gamma$ MATRICES. J. S. R. Chisholm (CERN, Geneva). Nuovo Cimento (10), 30: 426-8(Oct. 1, 1963).

If S and S′ are products of $\gamma$ matrices containing an odd number of $\gamma_\mu$ ($\mu = 0, 1, 2, 3$) and any number of $\gamma_5$, and if $\gamma_\alpha \ldots \gamma^\alpha$ is the relativistic scalar product, then $\mathrm{Tr}[\gamma_\alpha S]\,\mathrm{Tr}[\gamma^\alpha S'] = 2\,\mathrm{Tr}[(S + S_R)S']$, where $S_R$ is obtained from S by reversing the order of all $\gamma$ matrices. (auth)

**7579** HYPERSPHERICAL HARMONICS AND TENSORS. P. Hillion (Institut Henri Poincaré, Paris). Nuovo Cimento (10), 30: 480-2(Oct. 1, 1963).

Hyperspherical harmonics, a relativistic extension of spherical harmonics, are obtained as special solutions to the three-dimensional wave equation, and generalized hyperspherical functions are used to define hyperspherical tensors. (C.E.S.)

**7580** A PERTURBATIVE EXPANSION FOR LARGE ANGULAR MOMENTA. V. De Alfaro, E. Predazzi, and C. Rossetti (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cimento (10), 30: 522-35 (Oct. 16, 1963).

A perturbative formalism is presented, in the framework of potential scattering, in which the usual energy denomina-

tors are substituted by angular-momentum denominators. The trick is accomplished by expanding the partial wave function over free wave functions of different angular momenta at the same energy. A perturbative expansion is also given for $f_0(\lambda, -k)/f(\lambda, -k)$ with $f_0$ and f the free and the exact Jost functions, respectively. The convergence of the solution improves for high angular momenta. (auth)

**7581** UNDECIDABILITY OF MACROSCOPICALLY DISTINGUISHABLE STATES IN QUANTUM FIELD THEORY. Arthur Komar (Syracuse Univ., N. Y. and Yeshiva Univ., New York). Phys. Rev., 133: B542-4(Jan. 27, 1964).

A heuristic discussion is presented regarding quantum field theory as a synthesis of the complementary theories of classical mechanics and quantum mechanics. If the states of quantum field theory are partitioned in equivalence classes accordingly as their occupation numbers differ in a finite or an infinite number of places, it is suggested that states be defined to be macroscopically distinguishable if they belong to different equivalence classes. It is then proved that there is, in general, no effective procedure for determining whether or not two arbitrarily given states of a quantum system having an infinite number of degrees of freedom are macroscopically distinguishable. (auth)

**7582** RADIATION FORCES IN INHOMOGENEOUS MEDIA. E. J. Post (Air Force Cambridge Research Labs., Bedford, Mass.). Phys. Rev., 133: A686-91(Feb. 3, 1964).

Force terms arising from radiation impinging on spatial and time inhomogeneities of a medium can frequently be represented by a simple partial differentiation operating on only the structural elements of the lagrangian. These power and force density terms are energy and momentum sinks (or sources) of the radiation field. They accordingly occur as right-hand members in the usual divergence expressions for energy and momentum. The method of description is illustrated for acoustic radiation, for electromagnetic radiation in a material medium, and for electromagnetic radiation in a gravitational field. A coherent discussion of different kinds of radiation requires a reevaluation of the concept of wave momentum. The particle-momentum concept is implicit in the modified concept of wave momentum for matter waves. It then appears that the symmetry of the energy-momentum tensor only holds for electromagnetic radiation in free space and for matter waves associated with free and noninteracting particles. (auth)

**7583** A NOTE ON THE FORMAL THEORY OF TRANSPORT COEFFICIENTS. Robert J. Swenson (Université Libre, Brussels). Physica, 29: 1174-80(Nov. 1963).

The non-Markoffian generalized master equation of Janner is used to describe the time dependence of a binary correlation function of fluxes. A transport coefficient is related to a Fourier transform of a correlation function and this allows it to be shown that for low-frequency processes a Markoffian Approximation to the generalized master equation is sufficient to determine exactly a low-frequency transport coefficient. This corresponds to a theorem first obtained by Balescu for the steady-state classical case, which is generalized to the low-frequency quantum mechanical case. (auth)

**7584** APPROXIMATE SOLUTIONS OF THE GENERAL RELATIVITY FIELD EQUATIONS WITH A SCALAR MESON FIELD. J. Hyde (Imperial Coll. of Science and Tech., London). Proc. Cambridge Phil. Soc., 59: 739-41 (Oct. 1963).

The Birkhoff theorem, that every spherically symmetric solution of the field equations of general relativity for empty space may be reduced by suitable coordinate transformations to the static Schwarzschild form, is extended to the case in which a scalar meson field with non-zero rest mass is present. (C.E.S.)

**7585** THE FIELDS OF AN ARBITRARILY MOVING DIPOLE. J. R. Ellis (King's Coll., London). Proc. Cambridge Phil. Soc., 59: 759-74(Oct. 1963).

The 4-dimensional tensor calculus is used to derive the retarded fields of an accelerated electric dipole of constant moment. Following the analogous case of the accelerated charge, it is shown that the result can be expressed concisely in terms of ordinary three-vectors. The radiation field is discussed for important cases including that of the slowly moving dipole. Cases are cited to exhibit the existence of a forward beam of radiation for uniform circular motion. (auth)

**7586** STATISTICAL MECHANICS OF A ONE-DIMENSIONAL COULOMB SYSTEM WITH A UNIFORM CHARGE BACKGROUND. R. J. Baxter (Australian National Univ., Canberra). Proc. Cambridge Phil. Soc., 59: 779-87(Oct. 1963).

An exact description of the statistical mechanics of a one-dimensional system of charged particles moving in a uniform neutralizing background of positive charge is obtained. These results are compared with the behavior of a one-dimensional system of equal numbers of positive and negative charged particles. Although the thermodynamics of the two systems differ, the discrepancy is small enough to indicate that the assumption of a uniform background of positive charge, common in statistical mechanical treatments of a plasma in equilibrium, may provide a good approximation to a real system of discrete charges. (auth)

**7587** AN APPLICATION OF HARMONIC COORDINATES IN GENERAL RELATIVITY. R. H. Boyer (Univ. of Liverpool). Proc. Cambridge Phil. Soc., 59: 835-6 (Oct. 1963).

It is supposed that the first derivatives of the components of a continuous metric tensor exhibit jumps across a non-null hypersurface, and it is shown that harmonic coordinates lead to an automatic smoothing of the metric. (C.E.S.)

**7588** RANDOM ELECTRODYNAMICS. T. W. Marshall (Univ. of the West Indies, Jamaica). Proc. Roy. Soc. (London), Ser. A, 276: 475-91(Dec. 17, 1963).

A study of a statistical ensemble of classical harmonic oscillators that is stationary in time, and whose position and momentum distribution functions are those of the corresponding quantum-mechanical oscillator in its ground state is presented. If the oscillating particle is charged, then in order to maintain the distribution stationary a certain random electromagnetic field must be present. The intensity distribution of the radiation field is calculated, and it is found to be identical with the photon vacuum of quantum electrodynamics. It is suggested, therefore, that this radiation field, which in quantum field theory is treated entirely formally, might exist in the classical sense. The method is extended to the excited states. It is found that the classical ensembles corresponding to these have probability distributions that may be negative. However, when attention is shifted to the quantum-mechanical mixture, this is no longer the case. Furthermore, the intensity distribution of the radiation field at temperature T is shown to be simply the sum of the Planck distribution and the previously obtained zero-temperature field. The application of these results to statistical mechanics is discussed. The treatment is non-relativistic throughout, but

radiative corrections of the type that give rise to the Lamb shift are an integral part of the theory. (auth)

**7589** A NOTE ON THE VAN HOVE-MIYATAKE CATASTROPHE. Hiroshi Ezawa (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 30: 545-9(Oct. 1963).

For the sake of interpreting the broken symmetry in terms of symmetric interaction, Nambu and others have recently invoked the orthogonality between the eigenstates of the free and the total hamiltonians, which is called the Van Hove-Miyatake catastrophe. It will not be superfluous to remark that the statement orthogonality is not suitable for what is taking place in their models. It should be expressed as the weak convergence to zero or non-existence of strong limit of the eigenvector of cutoff total hamiltonian for increasing cutoff momentum (in some models, for increasing volume in which fields are confined). The condition for the catastrophe not to arise is presented and compared with the condition for the total hamiltonian to be a proper operator. The non-occurrence of the orthogonality does not necessarily mean that the total hamiltonian can be diagonalized, unless the vacuum energy is subtracted. The model used is the neutral scalar field interacting with a fixed source. (auth)

**7590** THEORY OF MEASUREMENT IN QUANTUM MECHANICS. DESTRUCTION OF INTERFERENCE. Saburo Amai (Univ. of Osaka Prefecture, Sakai). Progr. Theoret. Phys. (Kyoto), 30: 550-62(Oct. 1963).

The question as to whether quantum mechanics can be applied to a macroscopic system, which was recently raised through discussions of the problem of how to interpret the so-called reduction of a wave packet is discussed. It is shown by a detailed analysis of the destruction of interference that brings about the reduction, that a supplementary assumption on the preciseness of measurements must at least be introduced in order to interpret the reduction process as an objective process, and it does not, however, necessarily imply inapplicability of quantum mechanics to a macroscopic system. (auth)

## Geophysics

*Refer also to abstract 7371.*

**7591** (RM-3527-NASA) ACCELERATION OF CHARGED PARTICLES BY HYDROMAGNETIC SHOCK WAVES. J. W. Kern (RAND Corp., Santa Monica, Calif.). Mar. 1963. Contract NASr-21(05). 31p. (N63-17101)

Two mechanisms for the acceleration of particles trapped in the magnetosphere are discussed. Both are associated with the propagation of strong hydromagnetic (HM) shock waves through the magnetosphere. One accelerates thermal electrons throughout the magnetosphere. The other affects energetic particles trapped in the magnetosphere and can lead to changes in their energy and pitch angle distributions. A single HM shock wave is shown to be capable of producing, by either (or both) mechanisms, significant ring currents. (auth)

**7592** (TID-19900) GAS EXCHANGE BETWEEN THE ATMOSPHERE AND OCEANS. Progress Report. Wallace Broecker (Columbia Univ., Palisades, N. Y. Lamont Geological Observatory. Geochemistry Lab.). Dec. 1963. Contract AT(30-1)-2493. 67p.

Progress in determining the average rate of gas exchange between the ocean and atmosphere as a function of geographic location is reported. Work in establishing pre-bomb levels of natural radiocarbon in the ocean is described. The Suess effect (reduction of the $C^{14}/C^{12}$ ratio resulting from the influx of $C^{14}$-free industrial $CO_2$) was measured at the ocean's surface and shown to be less than 1%. The implication of this result to the problem of gas exchange over oceans is discussed. Samples are being collected at Fairbanks, Alaska, Hilo, Hawaii, and Antofagasta, Chile to determine the $C^{14}/C^{12}$ ratio in the atmosphere as a function of time. Samples of sea water were collected by the Columbia R/V Vema and in two expeditions to the Bahama Banks to obtain vertical profiles so that the total amount of bomb-produced $C^{14}$ can be estimated. Data are given in tables, figures, and graphs. Use of the $Rn^{222}/Ra^{226}$ ratio in gas-exchange studies is discussed. (M.C.G.)

**7593** I.G.Y. ASCAPLOTS. HALF-HOURLY AURORAL ALL-SKY CAMERA PLOTS FROM 115 STATIONS FOR THE PERIOD 1958-1959. W. Stoffregen, ed. Ann. Intern. Geophys. Yr., 20: 151-307(1963).

Half-hourly auroral all-sky camera plots are given for the period July 1, 1958 to April 30, 1959. A list of institutions contributing to the ascaplots and maps giving their locations are also included. A brief survey of the various camera types involved in the program is given. (C.E.S.)

**7594** ENVIRONMENTAL ELECTRICITY. Seymour Tilson, ed. Intern. Sci. Technol., No. 25, 24-34(Jan. 1964).

The variable fluxes of electromagnetic radiation and plasma reaching the earth from the sun that interact with the earth's magnetic field and atmosphere to generate electric currents that pervade every terrestrial environment are discussed. Such externally induced currents range from a mere 1800 amp that continuously leaks from the entire earth's surface to the air, to a more intense but intermittent flow of perhaps 500,000 amp in part of the ionosphere when auroras occur. These and other flows are quite feeble in contrast to an internal current of $10^9$ amp, generated in the earth's liquid core by the same self-inducing dynamo action that supports the magnetic field. This current, however, is confined to the core by the poor conductivity of the overlying mantle. But external current systems in the ionosphere, lower atmosphere, and earth's crust are not closed circuits. Various mechanisms, such as the aurora in the ionosphere and lighting in the lower atmosphere, transfer electrons from one component circuit to another. Such electro-transfer mechanisms are not only important in the planet's over-all electrical budget; they also may have been critical in life's origin and evolution. (auth)

**7595** EVIDENCE FOR THE EFFECT OF CORPUSCULAR RADIATION ON THE IONOSPHERE. F. Mariani (Università, Rome). J. Atmospheric Sci., 20: 479-91(Nov. 1963).

The correlation of maximum electron density in the F region at noon with solar activity is investigated for both long-term and month-to-month variations, in data for 1937-57 from all existing observatories. On the basis of noon-equilibrium between electron loss and ion production by solar radiation, an ionizing effect, strongly dependent on solar activity and peaked at latitudes of 55 to 65 deg, is shown to exist. This latitudinal variation suggests a corpuscular origin of the effect. The possible source of a corpuscular flux is discussed. The energy of the ionizing particles is in the kev range. Quantitative evidence is given that Van Allen belts could be an important, or possibly the main, source. (auth)

**7596** SUDDEN ENHANCEMENTS OF F-LAYER IONIZATION IN POLAR REGIONS. Geoffrey E. Hill

(AVCO Corp., Wilmington, Mass.). J. Atmospheric Sci., 20: 492-7(Nov. 1963).

A study of the morphology of large sporadic enhancements of F-region electron density in the darkened portions of the polar cap reveals a close connection between "Sporadic F" and ionospheric current systems. This connection arises from electric fields that are set up by these currents and then transferred to the F-region along an essentially vertical magnetic field. Under the influence of the electric and magnetic fields, a horizontal drift of ionization may become sufficiently strong to cause the development of sporadic F. Drift velocities obtained from synoptic analyses range between 2000 and 5000 kilometers per hour and agree with theoretical estimates. Criteria are presented for the development of sporadic F events, and the general diurnal and seasonal variations in the frequency of occurrence are inferred. (auth)

**7597** ON THE LOCATION OF THE IONOSPHERIC CURRENT SYSTEM CAUSING GEOMAGNETIC SOLAR FLARE EFFECTS. K. S. Raja Rao and M. Panduranga Rao (Colaba Observatory, Bombay). J. Atmospheric Sci., 20: 498-501(Nov. 1963).

The geomagnetic crochets recorded at Alibag, Annamalainagar, and Trivandrum by the solar flare of July 12, 1961, are examined with reference to the normal $S_q$ currents prevailing over these stations at the time of the solar flare. The large change in declination at Alibag and changes in horizontal intensity at Annamalainagar and Trivandrum indicate that the solar flare current system is an intensification of the normal $S_q$ current system. Evidence in favor of this conclusion is sought for in the solar flare effects recorded at Alibag by the flares of November 19, 1949, March 19, 1948, and October 14, 1953. A plot of the amplitudes of the solar flare effects in the horizontal intensity at Alibag, Annamalainagar, and Trivandrum during the period 1958-59 shows daytime enhancement of the flare effect at the latter two stations only, indicating a close connection between the crochet current system and the electrojet. It is therefore established that the crochet current system is an enhancement of the normal $S_q$ current system. (auth)

**7598** HIGH-LATITUDE GEOPHYSICAL STUDIES WITH SATELLITE INJUN 3. 3. PRECIPITATION OF ELECTRONS INTO THE ATMOSPHERE. B. J. O'Brien (State Univ. of Iowa, Iowa City). J. Geophys. Res., 69: 13-43(Jan. 1, 1964).

The precipitation of electrons with energy $E_e \geq 40$ kev into the atmosphere over North America is analyzed. Measurements were made principally with three directional Geiger tubes. It is shown that the intensity of electrons mirroring at the satellite altitude increases rather than decreases when precipitation occurs, for example, over an aurora. The precipitation process is such that the angular distribution of electrons tends to approach isotropy over the upper hemisphere at the satellite altitude. The flux of electrons with $E_e \geq 40$ kev backscattered by the atmosphere is about ten per cent of the precipitated flux. No events were found where the upflux exceeded the downflux, and it is concluded that most acceleration processes take place high above the satellite, accelerating electrons preferentially parallel to the magnetic field lines. It is shown that electrons with $E_e \geq 1$ Mev trapped around L ~4 are not perturbed when electrons with $E_e >$ 40 kev are precipitated at the same place, and so it is considered that the precipitation is not caused just by a gross change in the magnetic field producing lowered mirror points. The dependence of precipitation on $K_p$, local and real time, L, and so on is summarized, and the implications are discussed. (auth)

**7599** HIGH-LATITUDE GEOPHYSICAL STUDIES WITH SATELLITE INJUN 3. 4. AURORAS AND THEIR EXCITATION. B. J. O'Brien and H. Taylor (State Univ. of Iowa, Iowa City). J. Geophys. Res., 69: 45-63(Jan. 1, 1964).

Photometric observations of auroras were made at altitudes of 250 to about 600 km over North America early in 1963. The magnetically oriented satellite simultaneously observed the precipitated electrons that caused the aurora and trapped electrons. The auroral zone, as defined on some fifty latitude surveys of the brightness of the $N_2^+$ emission at 3914 Å, showed an average maximum brightness of about two kilo-rayleighs at an invariant latitude around 69° on the magnetic shell L = 7.8. Several visible auroras are discussed in detail. It is suggested that the auroras delineated the outer edge of the region of durable trapping of Van Allen electrons, and that the electrons causing the auroras and having an isotropic angular distribution over the upper hemisphere at the satellite altitude were mostly freshly accelerated rather than old electrons of the Van Allen belts with similar energy. In two auroras measured near perigee, less than 0.1 per cent of the oxygen 5577 Å emission came from altitudes above 250 km. Hence the flux of electrons of energy ~10 ev was no larger than the flux of those with ~10 kev. (auth)

**7600** HIGH-LATITUDE GEOPHYSICAL STUDIES WITH SATELLITE INJUN 3. 5. VERY-LOW-FREQUENCY ELECTROMAGNETIC RADIATION. D. A. Gurnett and B. J. O'Brien (State Univ. of Iowa, Iowa City). J. Geophys. Res., 69: 65-89(Jan. 1, 1964).

A preliminary report of very-low frequency (VLF) electromagnetic radiation measurements made by the Injun 3 satellite in the altitude range 250 to about 2000 km over North America from December 1962 to March 1963 is presented. The radiation is received by a loop antenna on the magnetically oriented satellite. Amplitude is measured with narrow-band filters at six frequencies, the lowest being 0.7 kc and the highest being 8.8 kc. A wide-band amplitude over the frequency band from 0.5 to 7.0 kc is also measured. In addition, the VLF signal modulates the telemetry transmitter so that a detailed spectral analysis can be made on the ground. It is found that the amplitude of naturally occurring VLF signals is commonly tens of decibels stronger at Injun 3 than on the ground, and this is to be understood as due to strong absorption of VLF energy in the ionosphere, as was found previously. The maximum observed signal strength over the band 0.5 to 7.0 kc is $5 \times 10^{-2}$ gamma. The amplitude of VLF chorus, considered for local times between 0800 and 1300, shows a maximum at L = 5 over the three-day period studied. Simultaneous occurrences of VLF electromagnetic emission, auroral optical emissions, and particle precipitation into the atmosphere were repeatedly observed. Two specific instances are discussed. In the more stable of the two, it is concluded that the auroral hiss was generated in the same magnetic shell in much the same region of the magnetosphere (near the outer boundary of trapping) as were the precipitated particles that caused the aurora. For this event it is estimated that, for the VLF radiation having frequencies less than 10 kc, the VLF energy flux at the satellite was about $8 \times 10^{-7}$ erg $cm^{-2}$ $sec^{-1}$, the energy flux of precipitated electrons was about 10 ergs $cm^{-2}$ $sec^{-1}$, and that from the auroral light was about 0.6 erg $cm^{-2}$ $sec^{-1}$. These measurements suggest that, in this

event, the electrons caused both the visible aurora and the VLF hiss emission. (auth)

**7601** EXCITATION BY LOCAL ELECTRIC FIELDS IN THE AURORA AND AIRGLOW. L. R. Megill (National Bureau of Standards, Boulder, Colo.) and N. P. Carleton. J. Geophys. Res., 69: 101-22(Jan. 1, 1964).

A method for accurate calculation of the distribution of electron energies in the ionosphere under the influence of an electric field is presented. From this calculation one can predict rates of excitation of radiating states of $N_2$, $O_2$, and O as a function of the strength of a hypothetical applied field. It is found that it is unreasonable to expect that electric fields are the source of the normal night airglow and that some of the consequences of fields adequate to generate the airglow are incompatible with observed facts. On the other hand, evidence is presented that certain auroral forms (especially the so-called midlatitude red arcs), in which the red lines 6300 to 6364 Å of atomic oxygen dominate the spectrum, are almost certainly caused by local electric fields, perpendicular to the magnetic field, and of the order of 1 mv/cm in strength. This hypothesis, as well as explaining quantitatively the preferential excitation of low-lying electronic levels in such auroral forms, is consistent with the observed height profiles of the red emission and with the increased drift velocity and decreased density of electrons that are observed to accompany midlatitude red arcs. A field of the magnitude required could be caused by separation of charge in the magnetosphere due to the solar wind. Because the conductivity parallel to the geomagnetic field is very much greater than that perpendicular to the field at all altitudes above 120 km or so, the electric field would exist everywhere in the ionosphere and magnetosphere above this altitude. This mechanism of generation would be consistent with the observed correlation of the occurrence of red arcs with other geomagnetic phenomena. (auth)

**7602** THEORY OF THE GEOMAGNETIC DAILY DISTURBANCE VARIATIONS. J. A. Fejer (Southwest Center for Advanced Studies, Dallas). J. Geophys. Res., 69: 123-37(Jan. 1, 1964).

The worldwide ionospheric current system predicted by a previously described theory of the auroral electrojets is computed. Tidal air motions are neglected at first, and the high-latitude current system is assumed to be due entirely to the interaction of magnetospheric rotation with the belt of energetic protons trapped in the distorted geomagnetic field. For a given geomagnetic distortion and trapped proton distribution, the computed current system strongly resembles Chapman's idealized $D_s$ current system, if sufficiently high E-region electron concentrations independent of geographical position are assumed. As the assumed electron concentrations are decreased, however, the intensity of the computed current system is reduced, first in the auroral zone and then at all latitudes; at the same time the phase of the current system is advanced in the polar cap and is retarded at low latitudes. In view of this limitation of the current system by the available electron concentrations, the large disturbance variations observed during an intense geomagnetic storm can be explained by this theory only if, in addition to an enhancement in the trapped proton density, greatly enhanced E-region electron concentrations are assumed, particularly in the auroral zone. Such enhanced electron concentrations are known to occur when blanketing sporadic E is observed. The observed correlation between blanketing sporadic E and the strength of the electrojet current is thus predicted by this theory. The interaction of the tidal wind system with the belt of trapped protons is also considered. The resulting auroral electrojet currents oppose the $D_s$ current system if the usually accepted pattern of upper atmospheric tidal winds is assumed; the existence of a different wind pattern at high latitudes, at least during geomagnetic storms, is a possibility that cannot altogether be excluded, although it appears unlikely. If the majority of energetic particles in the radiation belt were electrons, their interaction with the usually accepted tidal wind pattern would result in the correct phase for the $D_s$ current system; satellite observations indicate, however, that the majority of the energetic particles are protons. This theory can also account for the generation of meridional static electric fields of the type that, according to a theory of Megill and Carleton, cause midlatitude red arcs. (auth)

**7603** ON THE INTERPRETATION OF THE SUDDEN COMMENCEMENT OF GEOMAGNETIC STORMS. E. J. Stegelmann and C. H. von Kenschitzki (Lockheed-California Co., Burbank). J. Geophys. Res., 69: 139-55(Jan. 1, 1964).

The propagation and geometric attenuation of hydromagnetic waves in the geomagnetic field are calculated by the methods of geometrical optics. The waves are assumed to be generated by point sources located at a distance of 6 earth radii from the center of the earth. It is shown that the ray tracing method cannot be used to explain the rise time of sudden commencements of geomagnetic storms. However, the calculated propagation times of hydromagnetic disturbances can give an understanding of delay times and latitude dependence of arrival times. If extended sources are considered, the following conclusion results from the analysis: According to geometric optics, hydromagnetic disturbances of the fast mode produced at 6 earth radii by the interaction of a solar plasma front with the earth's magnetosphere will reach the earth only if they are produced in a region within a radius of a few thousand kilometers of the subsolar point. (auth)

**7604** HYDROGEN DIFFUSION IN THE THERMOSPHERE BY MONTE CARLO METHOD. S. O. Kastner (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 69: 157-64(Jan. 1, 1964).

The diffusion-limited flow of hydrogen in the thermosphere is obtained by a Monte Carlo calculation. The resulting density distribution has a steeper gradient than current theories predict, even taking omission of gravity into account. The departure is ascribed to increasing nonvalidity of the Chapman-Enskog diffusion coefficient as density changes over a mean free path become significant. (auth)

**7605** CLASSIFICATION OF GEOMAGNETIC MICROPULSATIONS. J. A. Jacobs (Univ. of British Columbia, Vancouver), Y. Kato, S. Matsushita, and V. A. Troitskaya. J. Geophys. Res., 69: 180-1(Jan. 1, 1964).

A proposed classification and notation for micropulsations of the geomagnetic fields is presented. (C.E.S.)

**7606** ON THE USE OF POSITRONS AS TRACERS TO STUDY THE MOTIONS OF ELECTRONS TRAPPED IN THE EARTH'S MAGNETOSPHERE. Edward W. Hones, Jr. (Inst. for Defense Analyses, Washington, D. C.). J. Geophys. Res., 69: 182-5(Jan. 1, 1964).

Positron injection into the magnetosphere is proposed as a method for investigating the dynamics of trapped electrons. To establish the feasibility of using positrons as tracers, a hypothetical experiment is analyzed. (C.E.S.)

**7607** S-BAND AURORAL RADAR RETURNS. L. H. Groth, L. J. Anderson, C. C. Easterbrook, and L. R. Burdette (Cornell Aeronautical Lab., Inc., Buffalo). J. Geophys. Res., 69: 194-6(Jan. 1, 1964).

Strong auroral radar echoes observed on the S-band carrier frequency are reported. Photographs illustrating several typical echoes and a plot of elevation angle vs the radar range of the returns are presented. (C.E.S.)

**7608** PRELIMINARY RESULTS FROM COORDINATED MEASUREMENTS OF AURORAS. J. E. Evans (Lockheed Missiles and Space Co. Research Labs., Palo Alto, Calif.) and A. E. Belon, comps. Trans. Am. Geophys. Union, 44: 1073-83(Dec. 1963).

Correlated measurements of the particles, luminosity, and ionization associated with auroral activity show good correlations in time and space for well-defined auroral forms. The lack of quantitative agreement between particle energy deposition for electrons having energies above 2 kev and ion-production rates, as obtained from luminosity measurements, indicates the need for lower-energy particle data. With high-resolution particle data from a complete satellite instrument package, and with a stable, homogeneous auroral arc or band as a subject, it should be possible to obtain much-improved time and space correlations. With low-energy particle detectors capable of detecting and measuring spectra and angular distributions of all particles that penetrate the atmosphere to the luminous regions, good correlations between particle energy deposition and luminosity can be expected. The relatively high levels of luminosity surrounding well-defined auroral forms might be caused by low-energy electrons that do not penetrate to the 100-km level. This luminosity could also be caused by protons with energies sufficiently low so that control by the geomagnetic field is lost during a major fraction of the time, i.e., when they are neutral. These factors emphasize the need for measurements, by combinations of low-energy electron detectors and by low-energy proton detectors, that can be interpreted to give detailed particle-energy deposit information. The high frequency of occurrence of auroras with easily measurable amounts of incident particles, luminosity, and atmospheric ionizations, even during this period of minimum solar activity, is especially encouraging. This exploratory investigation has demonstrated the feasibility and value of such a coordinated program of measurements as an approach to auroral research. (auth)

**7609** METHODS OF MEASUREMENT. (MESSMETHODEN). G. Schumann. p.295-342 of "Nuclear Radiation in Geophysics." New York, Academic Press. 1962.

Problems of low-level counting that arise in the measurement of radioactivity in geophysics are discussed. The problems considered are: general principles of measurement of low radioactivities; statistics; efficiency of the counter tube; null effect reduction; electronics; application of various detectors such as the ionization chamber, Geiger counter, proportion counter, and scintillation counter; radiochemical methods including the relationship among unweighable substances, operation procedures, and special radionuclides; sampling, including gas and aerosol samples, precipitation and water samples, mineral and soil samples; measurements of gases including the inactive gases and $C^{14}$ and $H^3$; measurements of aerosols and water samples including procedures with aerosol samples; measurements of fluids; enrichment of fluid samples; analysis of precipitable and energy discrimination; measurement of mineral and soil samples including total radioactivity; $\alpha$- and $\beta$-spectroscopy; and measurements with photoemulsions and fluorimetry. (Public Health Eng. Abstr., 43, Dec. 1963)

**7610** ELECTROMAGNETIC AND CORPUSCULAR HEATING OF THE UPPER ATMOSPHERE. Luigi G. Jacchia (Smithsonian Institution, Cambridge, Mass.). p.3-18 of "Space Research. III." New York, Interscience Publishers, 1963.

An analysis of newly derived, high-accuracy accelerations of eight satellites in eccentric orbits, with perigee heights between 350 and 750 km, during the years 1958-1961, leads to the following conclusions: Nicolet's 1961 atmospheric model based on diffusion equilibrium, in which helium plays an important role, yields consistent atmospheric temperatures at all heights. Paetzold's semi-annual effect is confirmed; it can be traced with decreasing amplitude throughout the three years covered by the observations. The erratic "27-day" density oscillations correspond to temperature oscillations $\Delta T = 2.5\ \Delta F_{10}$ °K where $\Delta F_{10}$ is the corresponding variation in the 10.7-cm solar flux. During magnetically disturbed days the atmospheric temperature is increased by an amount $\Delta T \approx 1° \times A_p$, where $A_p$ is the daily geomagnetic planetary index. When the daily atmospheric temperatures are corrected to a standard solar flux with the relation $\Delta T = 2.5\ \Delta F_{10}$ °K, there remains a systematic temperature decrease that roughly parallels the smoothed values of the decimetric solar flux or of the Wolf numbers. This effect could be minimized assuming that $\Delta T/\Delta F_{10} = 4.5$ instead of 2.5, but then the erratic fluctuation becomes overcorrected. It is suggested that the systematic temperature decrease and the semiannual effect have a single underlying cause—corpuscular radiation, whose flux varies with the 11-year solar cycle. It appears that the corpuscular component in the heating of the upper atmosphere is quite considerable. (auth)

**7611** SOLAR EFFECTS ON AIR DENSITY AT 200 AND 230 km. D. P. McDermott and G. V. Groves (University Coll., London). p.19-26 of "Space Research. III." New York, Interscience Publishers, 1963.

A detailed analysis is reported of the air density, derived from the orbit of 1960 o (Discoverer 18), at heights around 200 km for the period 16th November-20th December 1960. This analysis and one of the orbit of 1960 $\mu$ (Discoverer 15) at a height of 230 km during the geomagnetic storm of 5th-6th October, 1960, indicate a close correlation between the air density and the geomagnetic activity without any detectable dependence on latitude. Air density is found to very linearly with the $a_p$-index over a wide range of activity; a small semiannual effect is to be expected on this account. The Discoverer-18 orbit also indicates an increase in density towards the night side of the atmosphere at 200 km, this being the reserve of the diurnal effect at greater heights. (auth)

**7612** SOLAR ACTIVITY EFFECTS IN THE UPPER ATMOSPHERE DEDUCED FROM SATELLITE OBSERVATIONS. H. K. Paetzold (Univ. of Cologne). p.28-52 of "Space Research. III." New York, Interscience Publishers, 1963.

The observed accelerations of 7 satellites are analyzed to derive the dependence of upper-air-density variations on the solar activity, local time, etc. A working model could be found in excellent agreement with the observations. The considerable influence of the interplanetary plasma (solar wind) on the upper air structure could be

confirmed. The temperature difference between the sunspot maximum and minimum results in the mean to 800°K. In the extremes, the exospheric temperature may vary the wide range between 3000 and 500 °K when all effects are included. As a consequence the composition of the upper air must also vary strongly. (auth)

**7613** HEATING OF THE UPPER ATMOSPHERE. Isadore Harris and Wolfgang Priester (NASA Goddard Space Flight Center, Greenbelt, Md. and Inst. for Space Studies, New York). p.53-76 of "Space Research. III." New York, Interscience Publishers, 1963.

The physical properties of the upper atmosphere are determined mainly by heat conduction, the heat sources, and the barometric law. An analysis of the integro-differential equation which describes these physical processes was carried out. It is found that heating of the thermosphere due to absorption of the solar extreme ultraviolet (euv) radiation alone cannot explain the observed diurnal variation of density and temperature. If an additional heat source is used, which has a maximum at about 9 h local time and a flux of 1 erg $cm^{-2}$ $sec^{-1}$, a time-dependent model of the upper atmosphere is obtained that is in good agreement with the observed densities. There is evidence that this additional heat source derives its energy ultimately from the solar corpuscular radiation. Models of the upper atmosphere for different levels of solar activity were calculated by varying the fluxes of both heat sources (euv and corpuscular heat source) in proportion to the long term averages of the 10.7-cm solar fluxes in order to account for different levels of solar activity during the solar cycle. The resulting night-time temperatures are in good agreement with observational models. (auth)

**7614** THE AERONOMIC PROBLEM OF NEUTRAL HELIUM AND HYDROGEN. M. Nicolet and G. Kockarts (Centre National de Recherches de l'Espace, Brussels). p.76-7 of "Space Research. III." New York, Interscience Publishers, 1963.

The vertical distribution of $He^4$, $He^3$, $H^2$, and H in the thermosphere was investigated, taking into account the various production rates in the mixing region and different escape rates above the thermopause. (auth)

**7615** VARIATIONS OF ATMOSPHERIC PROPERTIES WITH TIME AND SOLAR ACTIVITY. H. K. Kallmann-Bijl (Univ. of California, Los Angeles). p.78-88 of "Space Research. III." New York, Interscience Publishers, 1963.

Average variations of atmospheric properties are derived from satellite observations. These variations may occur over a 24-hour period at altitudes between about 200 and 800 km. For the analysis, a medium solar activity was assumed. Numerical tables and figures for the possible variations with time at 350 km and at 650 km are given. Density, pressure, scale height, molecular weight, temperature, and thermal heat flow variations with time are shown. Daily variations of density that may be expected at these altitudes during maximum and minimum solar activity were calculated. It is shown that the density at 650 km at night (about two hours before local sunrise) during minimum solar activity, may differ by a factor of 200 from the density at daytime (about two hours after local noontime) during maximum solar activity. (auth)

**7616** CHEMISTRY OF THE UPPER ATMOSPHERE. V. I. Krassovskii (Inst. of Physics of the Atmosphere, Moscow). p.96-116 of "Space Research. III." New York, Interscience Publishers, 1963.

Within the existing uncertainty of the reaction-rate coefficients it is impossible to specify reliably the most likely processes of the upper atmosphere. It is quite evident that specified or rather reliable, noncontradictory values of constants for reactions possible in the upper atmosphere are required. Of enormous significance would be complex studies directly in the upper atmosphere at its various levels, in different latitudes, at various hours of day and night, and at different seasons and time periods during the solar activity cycles. It is necessary to determine simultaneously the concentration of oxygen and nitrogen molecules, and atoms, of hydroxyl, peryhydroxyl, and water molecules, of atomic and molecular hydrogen, of nitrogen oxide and dioxide, of carbon dioxide and molecules, of vibrationally excited molecules, and of all kinds of ions. (auth)

**7617** GRAVITATIONAL SEPARATION, COMPOSITION AND THE STRUCTURAL PARAMETERS OF THE ATMOSPHERE AT ALTITUDES ABOVE 100 km. A. A. Pokhunkov (Inst. of Applied Geophysics, Moscow). p.132-42 of "Space Research. III." New York, Interscience Publishers, 1963.

The results of measurements of the neutral composition of the atmosphere, made with a radiofrequency mass spectrometer during 2 soundings of geophysical rockets in the middle latitudes of the USSR (September 1960 (night) and November 1961 (day)), are given. Gravitational separation of Ar and $N_2$ gases is found. According to the first sounding data, the height of the beginning of diffusive separation is about 110 km. The atmospheric temperature distribution was measured up to an altitude of 210 km for the night-time experiment and 300 km for the day-time experiment. During the night-time experiment, the distribution of relative and absolute concentrations of $N_2$, O, and $O_2$ was found up to 210 km altitude. From 100 to 210 km altitudes, the mean molecular weight, the pressure, and the density of the atmosphere were also estimated. (auth)

**7618** STRUCTURE OF THE UPPER ATMOSPHERE DEDUCED FROM CHARGED PARTICLE MEASUREMENTS ON ROCKETS AND THE EXPLORER VIII SATELLITE. R. E. Bourdeau and S. J. Bauer (Goddard Space Flight Center, Greenbelt, Md.). p.173-93 of "Space Research. III." New York, Interscience Publishers, 1963.

Ion composition measured directly at altitudes above the F2 peak on the Explorer VIII satellite is compared with that obtained indirectly from recent rocket measurements of charged-particle densities. These data show that there are two transition regions (from oxygen to helium ions and from helium to hydrogen ions) in the upper ionosphere rather than a single transition from oxygen to hydrogen ions as previously believed. The results place the altitude at which the ratio $O^+/He^+$ has a value of unity between 800 and 1400 km depending on the atmospheric temperature. The atmospheric temperature was measured simultaneously and in the upper ionosphere and was found to be constant with altitude within a few percent. The experimental data are consistent with a previously developed empirical relation that predicts the altitude of the two transition levels as a function of diurnal time and of solar cycle. Langmuir probe measurements of electron temperature made on the Explorer VII satellite together with those obtained on recent rocket flights are compared with reference atmospheres. This comparison favors the concept of temperature equilibrium in all but the lower F region of the quiet daytime ionosphere. A revision of theoretical considerations based on present knowledge of ionizing radiation and energy transfer mechanisms

is offered as an explanation for the observed detailed altitude dependence of the difference between electron and neutral gas temperatures. A diurnal temperature variation of about eighty percent is indicated in the isothermal altitude region of the upper atmosphere from a comparison of Explorer VIII data and several rocket measurements of charged particle densities. (auth)

**7619** SPATIAL AND TEMPORAL VARIATIONS OF ELECTRON DENSITY FROM AN ORBITING SATELLITE. J. C. Ulwick and W. Pfister (Air Force Cambridge Research Labs., Bedford, Mass.). p.194-208 of "Space Research. III." New York, Interscience Publishers, 1963.

An antenna impedance probe for the determination of electron density in the ionosphere was on the Discoverer Satellite No. 34 launched on November 5, 1961, at 1200 hours PST. The impedance measuring system used a standing-wave technique at 7.2 Mc. 40 real time readouts of the measurements were made at the rate of 5 per second at four different satellite tracking stations. In addition, 17 tape readouts are available varying in coverage from ½ orbit to 2 orbits with measurements being made every second. The satellite was in a near polar orbit with a 250 km perigee and a 1000 km apogee. The electron densities measured at perigee below the peak of the $F_2$ layer compare favorably with ionosonde data. On the night side above 600 km the electron density is almost constant with a value about $3 \times 10^4$. On some of the orbits a pronounced peak with up to $2 \times 10^5$ electron/cm$^3$ was observed at 650 km in the southern auroral zone. A systematic change of the results occurs as a function of position on the globe. Also, day-to-day variations in the vicinity of perigee in the E zone were observed. (auth)

**7620** PROFILE OF CHARGED PARTICLE DENSITY IN THE IONOSPHERE OBSERVED WITH ROCKETS. Y. Aono, K. Hirao, and S. Miyazaki (Radio Research Labs., Tokyo). p.221-7 of "Space Research. III." New York, Interscience Publishers, 1963.

Nine sounding rockets used to measure the ionosphere were fired in Japan since September 1960. The first three rockets installed the positive ion detector, and the next five rockets the Ionospheric Direct Sounding Instrument which contained the ion probe, the Langmuir probe for electrons, and the resonance probe, and the last one only the resonance probe. The maximum altitude in the last one was almost 350 km and in other cases about from 140 km to 200 km. A mean profile of the electron and ion densities of the ionosphere are presented using the data obtained by these rocket observations. The calculated results show that both ion and electron profiles agree mutually except at the levels between 100 to 115 km, in which level ion density is larger than electron density and it suggests the existence of negative ion. The h′-f curves were calculated from the data observed by the sounding rocket. These calculated h′-f curves show good agreements with the h′-f curves observed in the vertical incidence sounding. The theory of resonance probe is briefly introduced. (auth)

**7621** ELECTRON DENSITY PROFILE ABOVE THE F2 PEAK FROM FARADAY RECORDS. E. Argence (Institut Franco-Allemand de Recherches, St. Louis, France) and K. Rawer. p.230-46 of "Space Research. III." New York, Interscience Publishers, 1963.

The Faraday effect is computed under the following assumptions. The inner ionosphere up to the peak is represented by a model consisting of three parabolic regions representing E, F1, and F2 layers. The relevant data of these layers are obtained from instantaneous maps of the main ionospheric parameters derived from individual soundings of a large number of European ionospheric stations. The outer ionosphere has a Chapman-Elias profile approximated by a combination of a $\cos^2$ layer and an exponential tail. The unknown thickness parameter q of the outer ionosphere is variable along the individual orbit. The magnetic field of the earth in the interesting zone is approximated by a dipole field best fitted to the actual magnetic data in Europe. The effect of ray refraction is calculated according to the model (magnetic double refraction is neglected for this calculation). The general expression of the Faraday rotation is obtained by third order serial development in X (relative electron density) and Y (relative gyrofrequency). The total rotation is calculated for the instantaneously given ionosphere as a function of q for some points where the observations on 40 MHz gave a zero of Faraday-fading. These computed values are compared with the observed differences. (auth)

**7622** EQUATORIAL ELECTRON DENSITY PROFILES TO 5,000 km, USING THE INCOHERENT SCATTER TECHNIQUE. K. L. Bowles (Jicamara Radar Observatory, Lima). p.253-64 of "Space Research. III." New York, Interscience Publishers, 1963.

Profiles of electron density over the height range 100 to 5000 km were measured using an incoherent scatter radar near the magnetic equator at Lima, Peru. The method produces a profile continuous through this height range. New observations are made at intervals of less than one hour permitting study of dynamic changes in the profile. Measured profiles are given as typical examples for daytime and nighttime. The electron density approximates $10^5$ per cubic centimeter at 600 km, $10^4$ at 1100 km, and $10^3$ at 4000 km. An intermediate region appears between 600 and about 2000 km. A distinct widening of the scatter spectrum at about 2000 km suggests the beginning of the protonosphere. Prospects are good for increasing the maximum height to 30,000 km. (auth)

**7623** EVIDENCE FOR FIELD-ALIGNED IONIZATION IRREGULARITIES BETWEEN 400 AND 1000 km ABOVE THE EARTH'S SURFACE. Thomas E. Vanzandt, Wynne Clavert, Robert W. Knecht, and Georganna Buckel Goe (National Bureau of Standards, Boulder, Colo.). p.271-3 of "Space Research. III." New York, Interscience Publishers, 1963.

Two rockets have carried fixed-frequency ionosondes to altitudes of about 1000 km east of Wallops Island, Virginia. Analysis of the records shows that the scale height (and temperature) were 72 ± 3 km (1150 ± 50°K) at about 1900 LMT and 53 ± 2 km (850 ± 30°K) at about midnight. There is strong evidence for field-aligned ducts (associated with bottomside spread F) with diameters mostly between 1 and 2 km, an average of 15 km apart, and extending at least from 400 to 1000 km. (auth)

**7624** SOME PROBLEMS CONNECTED WITH RECOMBINATION AND IONISATION PROCESSES IN THE EARTH'S ATMOSPHERE. A. D. Danilov (Inst. of Applied Geophysics, Moscow). p.274-81 of "Space Research. III." New York, Interscience Publishers, 1963.

A formula for the diurnal variation of the recombination coefficient, $\alpha'$, is obtained. On the basis of experimental data on neutral and electron density variations occurring between day and night at altitudes of 100 to 600 km the ratio, $(\alpha')$ night/$(\alpha')$, was determined. The ionization coefficient for altitudes between 100 and 400 km is calculated.

It is shown that at altitudes of 160 to 400 km, the atmospheric ionization is produced by an agent having a high absorption coefficient for atmospheric components. This agent is supposed to be electron fluxes. (auth)

**7625** ELECTRON TEMPERATURES IN THE UPPER ATMOSPHERE. W. B. Hanson (Lockheed Missiles and Space Co., Palo Alto, Calif.). p.282-302 of "Space Research. III." New York, Interscience Publishers, 1963.

Ionospheric electron temperatures were recalculated using better cross-section data than was used by Hanson and Johnson. It is shown, on the basis of solar ultraviolet heating, that the electron temperature should deviate most markedly from the neutral particle temperature near 200 km, and that this maximum deviation could be of the order of 1000°K. It is shown that photoelectrons released above about 300 km may escape the ionosphere and cause a flux of fast electrons of the order of $10^8$ electrons/$cm^2$ sec at very high altitudes. The tenuous nature of the ionosphere above 300 km makes the calculation of the electron temperature in this region very difficult, and its evaluation was carried out only with the application of rather arbitrary assumptions. (auth)

**7626** ON THE RATE OF IONIZATION AND RECOMBINATION PROCESSES IN THE IONOSPHERE. G. S. Ivanov-Kholodny (Inst. of Applied Geophysics, Moscow). p.303-9 of "Space Research. III." New York, Interscience Publishers, 1963.

An analysis is given of several rocket experiments dealing with intensity measurements of the solar extreme ultraviolet radiation and the ion composition and corpuscular radiation measurements in the ionosphere. This analysis shows that ionization and recombination rates exceed the rates used in the past many times. These conclusions are confirmed by some ground ionosphere experiments. It is necessary to reconsider the earlier data used for estimating the effective recombination coefficient in the ionosphere, in order to arrive at a new concept of the main elementary processes in the ionosphere. (auth)

**7627** ORIGIN AND MECHANISM OF THE VLF EMISSIONS. K. I. Maeda and I. Kimura (Kyoto Univ.). p.310-23 of "Space Research. III." New York, Interscience Publishers, 1963.

A brief review is given on the statistical results of the observed vlf emissions and on some theoretical interpretations of the phenomena, and a new theory of the origin and mechanism of the emissions is proposed. The radio noise probably existing in the exosphere is examined as a possible source of the vlf emissions. Due to the whistler mode of propagation, the atmospheric noise generated in the troposphere is able to invade into the exosphere when the absorption in the ionosphere is small enough. This kind of noise is estimated to have a flux density of about $10^{-15}$ $W/m^2$ c/s or more and is by far stronger then the emission generated by injected high energy particles. A new mechanism of vlf wave amplification is proposed. A transverse coupling of the proton cyclotron-mode with the whistler-mode radio wave is able to cause the amplification of about $2 \times 10^{-2}$ dB/km in the exosphere if the proton density of the beam is as high as 10 $cm^{-3}$. From the conditions for the amplification, two frequencies are prescribed, which provides an explanation of the frequency-time characteristics of the discrete vlf emissions. (auth)

**7628** ON SOME RESULTS OF THE EARTH'S MAGNETIC FIELD INVESTIGATIONS IN OUTER SPACE. S. Sh. Dolginov and N. V. Pushkov (Inst. of Terrestrial Magnetism, Ionospheric and r.w. Propagation, Moscow). p.331-41 of "Space Research. III." New York, Interscience Publishers, 1963.

Attention is drawn to the agreement in sign, character of variation in space, and order of magnitude of the differences between measured and calculated values of the magnetic field in the outer radiation zone found by both the Soviet space probe II and Explorer X on magnetically quiet days. Deviations of 8-11% and 5-8%, respectively, from the calculated values, detected as a result of these experiments, at a distance of 2.5-3.5 $R_E$, are compared with deviations of 0.2-1% revealed at lower altitudes (Sputnik III measurements) from computed values based on the first eight coefficients of the Gauss series. Magnetograms are presented showing that the time of the space probe I flight included a small ($D_{st}$ = 20 gammas) world magnetic storm with a sudden commencement (SSC = 10 gammas), which had a 27-day cycle. The conclusion of the perturbed condition of the outer zone on the day of the space probe I flight is also based on a comparison of the energy release levels from radiation counters sensitive to bremsstrahlung electrons during the flights of space probes I and III, on the one hand, and space probe II, on the other. Magnetic measurements carried out during the flights of space probes I and II suggest that at a distance of 2.5-3.5 $R_E$, a diamagnetic effect in the outer zone is displayed that always exists, but is especially large during magnetic storms due to the drift-current system. An opinion is expressed that quantitative disagreement between magnetic effects and radiation measurements could be the consequence of the fact that protons, whose existence is suggested by the presence of magnetic effects, have not yet been detected in the outer zone. Space probe I and II measurements are compared with those obtained with Explorer VI. (auth)

**7629** SOME RESULTS OF THE CONSTANT GEOMAGNETIC FIELD MEASUREMENTS CARRIED OUT FROM SPUTNIK III OVER THE TERRITORY OF THE USSR. S. Sh. Dolginov, L. N. Zhuzgov, N. V. Pushkov, L. O. Tyurmina, and I. V. Fryazinov (Inst. of Terrestrial Magnetism, Ionospheric and r.w. Propagation, Moscow). p.342-54 of "Space Research. III." New York, Interscience Publishers, 1963.

Comparison of the measured values of the intensity with those calculated on the basis of the 62 coefficients (n = 9, m = 6) of the geomagnetic potential expansion in a series of spherical harmonics established their correspondence within 0.1-1% over most of the territory of the USSR, including the Siberian world magnetic anomaly. This conclusion is illustrated by a limited number of typical magnetograms obtained on those circuits that traversed the whole territory of the USSR. A brief description of the metrological properties of the apparatus in use and the technique of eliminating the magnetic interference aboard the satellite from the Sputnik III magnetograms are presented. (auth)

**7630** ON THE THINNESS AND ORIENTATION OF AURORAL ARCS. W. I. Axford and C. O. Hines (Defence Research Board, Ottawa). p.355-7 of "Space Research. III." New York, Interscience Publishers, 1963.

Auroral arcs are typically thin in one horizontal direction and long in another. The majority of arcs observed by Davis in Alaska were aligned in directions nearly parallel to the direction of current flow in the Ds system. These two characteristics receive a ready explanation on the basis of the authors' magnetospheric convection theory of disturbance phenomena: the elongation is produced by shear in the convection, and it is oriented along the convective flow lines that are also lines of the Hall currents

that produce Ds. Secondary factors that can enhance the elongation are also discussed. A second class of arcs not obviously related to the Ds pattern may also exist, and it is associated by us with energetic particles whose motions are controlled more by the magnetic field gradient than by the electric field of the convective system. (auth)

**7631** LOW-ENERGY TRAPPED PROTONS. L. R. Davis and J. M. Williamson (NASA Goddard Space Flight Center, Greenbelt, Md.). p.365-75 of "Space Research. III." New York, Interscience Publishers, 1963.

A scintillation detector designed to measure the directional intensity and spectrum of 100-kev to 4.5-Mev protons and the directional energy flux and spectrum of 10-kev to 100-kev electrons was flown on the Explorer XII satellite. Analysis of a portion of the data recorded during the last half of August 1961 has shown: (1) that the radial distance to the outer boundary of the geomagnetically trapped radiation is variable, ranging from 8.5 to 11.0 Earth radii, (2) that electrons are trapped more or less uniformly from 2 Earth radii to the outer boundary, and (3) that protons are trapped throughout the same region. The proton intensity peaks on the dipole field line having an $R_0$ value of about 3.5 Earth radii, where the maximum intensity is $6 \times 10^7$ protons per $cm^2$ sec sr. The proton spectra may be approximated by exp $(-E/E_0)$ with, for example, $E_0$ values of 400, 120, and 64 kev at $R_0$ values of 2.8, 5.0, and 6.1 Earth radii, respectively. During the magnetic storm which began on 30 September 1961, the proton intensity, measured at high latitudes, was enhanced by a factor of three. The possibility that the main phase decrease of the storm was produced by the protons is discussed. (auth)

**7632** ELECTRON PRECIPITATION AND THE OUTER RADIATION ZONE. B. J. O'Brien and C. D. Laughlin (Iowa State Univ., Iowa City). p.399-417 of "Space Research. III." New York, Interscience Publishers, 1963.

The electrons in the outer radiation zone were studied with satellites Injun I and Explorer XII, and time-averaged results for mid-1961 are presented. In the equatorial plane the omnidirectional intensity of electrons with E > 40 kev is of order $10^7$ particles $(cm^2\ sec)^{-1}$ between two and ten earth radii. The time-averaged outflux of these electrons at 1000-km altitude over North America is $\sim 10^3$ particles $(cm^2\ sec)^{-1}$ at mid-latitudes and $\sim 10^5$ particles $(cm^2\ sec)^{-1}$ in the auroral zone. Hence a characteristic lifetime for these electrons is a few hours. The excitation of auroras and airglow by electron precipitation is examined. The wide variations in electron spectra seen by both satellites are shown. (auth)

**7633** PARTICLE FLUX MEASUREMENTS FROM AN ATLAS POD IN THE LOWER VAN ALLEN BELT. W. L. Imhof, R. V. Smith, and P. C. Fisher (Lockheed Missiles and Space Co., Palo Alto, Calif.). p.438-46 of "Space Research. III." New York, Interscience Publishers, 1963.

Proton and electron fluxes in the Van Allen belt were measured with an instrument package in a pod carried aloft by an Atlas missile. Proton spectra and angular distributions were measured in the energy range of 28 to 72 Mev with a counter telescope consisting of a thin dE/dx scintillator and a thick E scintillator. Proton energy spectra were obtained from the pulse heights observed in the E crystal. Analysis was by a 16-channel pulse-height analyzer, coded in binary form for telemetry to the ground stations. Higher energy protons were measured with two other scintillators and a Geiger counter with thresholds provided by their shielding of 76, 128, and 76 Mev, respectively. Electrons were measured with a detector consisting of a permanent magnet and a plastic scintillator, whose pulses were analyzed by electronics similar to that of the counter telescope. Spectra obtained with all of these counters and angular distributions observed with the proton telescope and the electron detector are presented. (auth)

**7634** THE ELECTRON SPECTRUM FROM 90 TO 1200 kev AS OBSERVED ON DISCOVERER SATELLITES 29 AND 31. L. G. Mann, S. D. Bloom, and H. I. West, Jr. (Univ. of California, Livermore). p.447-62 of "Space Research. III." New York, Interscience Publishers, 1963.

The electron spectrum was measured in nearly polar orbits at altitudes of ~100 to 350 miles on Discoverers 29 and 31 with a 10 channel electron spectrometer (energy range 94 to 1220 kev) looking outward along a radius vector of the earth. Three types of spectra were observed: Type A: observed in channel 1 only (94 ± 14 kev) and often exhibiting fluxes $>1.5 \times 10^5$ electrons/$cm^2$-sec-sr-kev. The A-flux seemed to be largely confined to the Northern Hemisphere. Type B: this flux was observed mainly in the southern auroral zone at energies below 300 kev and occurred in the form of jets or sharp rises in counting rate. Type C: observed in the region of the South Atlantic dipolar anomaly. This spectrum has a broad maximum ranging from 600 to 1000 kev. The C-flux changed smoothly as the spectrometer passed through the anomaly (~1500 miles in extent), the maximum observed flux being ~480 electrons/$cm^2$-sec-sr-kev. It showed a high temporal stability in all channels, unlike the A and B fluxes which were almost totally absent from flight 31, a period of relatively low magnetic activity. (auth)

**7635** PROTON FLUX MEASUREMENTS FROM SATELLITES 1961 SIGMA-1 AND 1961 ALPHA DELTA-1 NEAR THE PEAK OF THE INNER VAN ALLEN BELT. R. V. Smith, P. C. Fisher, W. L. Imhof, R. D. Moffat, and J. B. Reagan (Lockheed Missiles and Space Co., Palo Alto, Calif.). p.463-76 of "Space Research. III." New York, Interscience Publishers, 1963.

Measurements of the high-energy proton flux in the inner belt were made at magnetic altitudes between 3300 and 3900 km on two satellites in polar orbit. The detectors consisted of scintillation counters having proton thresholds ranging from 25 to 128 Mev provided by their shield thickness, and a Geiger counter with a proton shield thickness of 60 Mev. The counting rate of each detector was determined from the telemetered output of a logarithmic count rate meter. Several passes at various longitudes show the lattitude dependence of the proton flux and indicate, within 20 degrees of the magnetic equator, a higher flux and a steeper altitude dependence than expected. Comparison of the Geiger counter and 60-Mev scintillator rates indicates that the particles being counted are protons. Comparison of the scintillator rates yields a proton spectrum, which changes with both latitude and altitude. (auth)

**7636** ELECTRON LOSS RATE FROM THE OUTER RADIATION BELT. W. N. Hess (Goddard Space Flight Center, Greenbelt, Md.), S. D. Bloom, L. G. Mann, F. D. Seward, and H. I. West, Jr. p.477-85 of "Space Research. III." New York, Interscience Publishers, 1963.

The rate of loss of electrons from the outer radiation belt is obtained by using recent electron flux measurements on Discoverer satellites and assuming that coulomb scattering dominates as the loss process. This results in an average lifetime of the order of 100 years for outer belt electrons. (auth)

**7637** EARTH'S UPPER ATMOSPHERIC AND EXOSPHERIC PHENOMENA DURING MAGNETIC STORMS.

S. Matsushita (High Altitude Observatory, Boulder, Colo.). p.716-31 of "Space Research. III." New York, Interscience Publishers, 1963.

After a study of the morphology of geomagnetic sudden commencements, their accompanying phenomena, such as sudden increases of cosmic noise absorption, bursts of bremsstrahlung x-rays, and commencements of geomagnetic micropulsations, are examined, and possible causes of these phenomena are discussed. Average storm duration during years of great solar activity is found to be about three times longer than that during years of small solar activity. This indicates a change in ring-current decay time with the solar activity cycle. Also, a large seasonal dependence of ionospheric storm-time variations, obtained from electron density profile data, suggests that ring-current effect on the ionosphere is different between summer and winter. (auth)

**7638** THE ROTATION OF THE EARTH AND SOLAR ACTIVITY. Andre Danjon (Observatoire, Paris). p.742-4 of "Space Research. III." New York, Interscience Publishers, 1963. (In French)

During a period of high solar activity (1956 to 1959), solar events did not have individual effects, but filled the space occupied by the earth with plasma. The time (T) required for the earth to complete one rotation about its axis varied continuously during this period, with a maximum that almost coincided with that of the solar activity. A solar event of exceptional intensity (July, 1959) caused a sharp discontinuity in T. When the solar activity is observed to decrease, it is found that smaller individual events become able to produce discontinuities in T. During times of solar calm, T is practically uniform. (T.F.H.)

**7639** A METHOD OF STUDYING THE ENERGY DISTRIBUTIONS OF IONOSPHERIC IONS AND ELECTRONS. R. L. F. Boyd and A. P. Willmore (University Coll., London). p.1168-73 of "Space Research. III." New York, Interscience Publishers, 1963.

The Ariel satellite, launched on April 26, 1962, carried three plasma probe experiments that were designed to study the energy distribution functions of the ionospheric charged particles using the Druyvestyn method of analyzing the probe characteristic. Two of the plasma probes, identical in design but located differently on the satellite, were used to obtain the electron energy distribution function, while the second operated on the positive ions. In this way, electron and positive ion densities and temperature and the positive ion mass spectrum can be obtained. The satisfactory operation of these experiments is reported, and some typical probe characteristics are shown. (auth)

## Low Temperature Physics

*Refer also to abstract 7547.*

**7640** SUPERCONDUCTIVITY AND VACANCY STRUCTURES OF THE PRESSURE-INDUCED NaCl-TYPE PHASES OF THE In–Te SYSTEM. S. Geller, A. Jayaraman, and G. W. Hull, Jr. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Appl. Phys. Letters, 4: 35-7(Jan. 15, 1964).

The pressure-induced NaCl-type phases of $In_{1-x}Te$, where $0 \leq x \leq 0.18$, were studied at 3.45 to 1.02°K. As the ratio In/Te decreases, the percentage of $In^{3+}$ ions in the crystal increases. (R.E.U.)

**7641** SUPERFLUIDITY. William H. Jones, Jr., William A. Jeffers, Jr., and Frederick J. Milford (Battelle Memorial Inst., Columbus, Ohio). Ind. Res., 5p.(Sept. 1963).

A brief outline is given of the properties of superfluid He II and superconductors. (T.F.H.)

**7642** STATIONARY ENTROPY PRINCIPLE AND RENORMALIZATION IN NORMAL AND SUPERFLUID SYSTEMS. I. ALGEBRAIC FORMULATION. Cyrano De Dominicis and Paul C. Martin (Centre d'Etudes Nucléaires, Saclay, France and Harvard Univ., Cambridge, Mass.). J. Math. Phys. (N. Y.), 5: 14-30(Jan. 1964).

It is shown how the dynamical and thermodynamical properties of an interacting quantum mechanical system with many degrees of freedom may be expressed and calculated solely in terms of renormalized propagators and renormalized vertices or interactions. The formulation employed is sufficiently general to encompass systems that have several components, with Fermi or Bose statistics, whether or not they exhibit superfluidity or superconductivity. The process of renormalization is the functional generalization of the thermodynamic transformation from the chemical potential and temperature to the energy and matter densities. With each set of variables (functions) is associated a natural thermodynamic function (functional). The natural functional for the unrenormalized potentials that occur in the hamiltonian is the logarithm of the grand partition function; the natural functional for the fully renormalized variables, the distribution functions, is the entropy. In particular, a stationarity principle for a functional $F^{(2)}$ of distribution functions subject to constraints is shown to provide a fully renormalized description of the system. The numerical value of this functional, at the stationarity point at which the distribution functions take their actual value, is the entropy of the system. The equations of stationarity are expressions for the unrenormalized $\nu$-body potentials $v_\nu$ in terms of the $\nu'$-body distribution functions $G_{\nu'}$. The functionals $F^{(2)}$ and $v_\nu$ (of the distribution functions $G_{\nu'}$) are expressed as the solutions of closed functional differential equations that may be used to generate their power-series expansions. For a superfluid Bose system, as for the electromagnetic field interacting with matter, it is necessary to consider expectation values of odd, as well as even, numbers of field operators. In particular it is necessary to employ the expectation values $G_i$ for $2\nu = 1, 2, 3, 4$ field operators. For a fermion system, even if it is superconducting, only the functions $G_\nu$ for $2\nu = 2, 4$ are required. In contrast to other thermodynamical functionals, the entropy functional $F^{(2)}$ makes no reference to equilibrium parameters such as temperature and chemical potential. (auth)

**7643** STATIONARY ENTROPY PRINCIPLE AND RENORMALIZATION IN NORMAL AND SUPERFLUID SYSTEMS. II. DIAGRAMMATIC FORMULATION. Cyrano De Dominicis and Paul C. Martin (Centre d'Etudes Nucléaires, Saclay, France and Harvard Univ., Cambridge, Mass.). J. Math. Phys. (N. Y.), [5]: 31-59([Jan. 1964]).

Quantum statistical mechanics is renormalized, that is, the thermodynamical functions and the bare $\nu$-body potentials $v_\nu$ occurring in the hamiltonian are expressed as functionals of the $\nu$-body distribution functions $G_\nu$ (the expectation values of $2\nu$ field operators). The field operators are considered as having two components (creation and annihilation), and $G_\nu$ thus has $(2)^{2\nu}$ components. The renormalization is carried out for superfluid Bose systems for which it is necessary to consider the expectation values $2\nu = 1, 2, 3, 4$ operators. Superfluid Fermi systems and normal systems appear as particular cases, described by expectation values of $2\nu = 2, 4$ operators. This problem is attacked by diagrammatic methods. These methods are more dependent on convergence properties but the result-

ing functionals are obtained explicitly as power series of the $G_\nu$'s, the general term being represented by a class of diagrams characterized by their topological structure. In the final result, the entropy is exhibited as an explicit functional of the distribution functions $G_\nu$, ($2\nu = 1, 2, 3, 4$), or more precisely, of functions directly related to them. This functional no longer involves the potentials (nor the equilibrium parameters). It is stationary under independent variations of the $G_\nu$'s, subject to the constraints of constant energy and particle number. The four equations of stationarity exhibit each function $\nu_\nu$ as a functional of the $G_\nu$'s, self-consistently defining these distribution functions. (auth)

**7644** A LIQUID DEUTERIUM TARGET. W. H. Evans (Univ. of Liverpool) and S. J. Hall. Nucl. Instr. Methods, 24: 345-8(Oct. 1963).

Details of design and method of construction of a small target suitable for liquid deuterium are given. (auth)

**7645** DESIGN OF A COOLING SYSTEM FOR D–Ti AND T–Ti TARGETS. J. Rethmeier and D. R. Van der Meulen (Vrije Universiteit, Amsterdam). Nucl. Instr. Methods, 24: 349-52(Oct. 1963).

A design of a cooling system for D–Ti and T–Ti targets is given, which can dissipate 4300 w/cm$^2$, while the target temperature does not rise above 115°C and the cooling fluid is water of 15°C. It is found that the cooling capacity is determined mainly by the heat transfer from the metal surface to water. (auth)

**7646** RADIAL FLOW OF SUPERFLUID HELIUM OVER A HORIZONTAL PLATE. P. W. F. Gribbon and J. A. Cope (St. Andrews Univ., Scotland). Phil. Mag. (8), 8: 2047-53(Dec. 1963).

A study was made of the nearly isothermal and nonisothermal flow of liquid helium II radially over a horizontal surface at a temperature of 1.65°K. At intermediate flow rates in the isothermal case the type of flow is that described by a hydraulic jump. At large flow rates an edge drop is formed whose maximum height is given by the height above the equator section of a classical nonwetting static sessile drop. (auth)

**7647** SPIN DIFFUSION IN GASES AT LOW TEMPERATURES. V. J. Emery (Univ. of California, Berkeley). Phys. Rev., 133: A661-4(Feb. 3, 1964).

It is shown that the first approximation to the spin-diffusion coefficient D of a gas at low temperatures involves a scattering cross section for distinguishable particles only, so that D is different from the self-diffusion coefficient $D_0$. Quantum symmetry effects show up in the second approximation to D but the correction to the first approximation is small. The theoretical values of D for gaseous hydrogen and gaseous $He^3$ agree quite well with experimental results. (auth)

**7648** SPIN DIFFUSION MEASUREMENTS IN HYDROGEN BETWEEN 20 AND 55°K. A. Hartland and M. Lipsicas (Rutgers Univ., New Brunswick, N. J.). Phys. Rev., 133: A665-7(Feb. 3, 1964).

The spin diffusion coefficient D of hydrogen was measured as a function of the density up to a maximum density of 850 amagats for various ortho-para hydrogen concentrations in the range 20–75% of orthohydrogen between 20 and 55°K by the spin echo technique. Within the experimental error of ±10%, the absolute value of D for the dilute gas is in agreement with the calculations of Buckingham et al. over this entire temperature range. Within this accuracy, no dependence on orthohydrogen concentration (at constant total density) is observed. The experimental results tend to confirm the conclusion of Emery, deduced from a detailed analysis of the Boltzmann diffusion equation, that symmetry effects cannot be observed in the diffusion process. (auth)

**7649** HIGH-MAGNETIC-FIELD SPECIFIC HEAT OF A LOW-DISLOCATION-DENSITY ALLOY SUPERCONDUCTOR. R. R. Hake (Atomics International, Canoga Park, Calif.) and W. G. Brammer. Phys. Rev., 133: A719-23(Feb. 3, 1964).

The specific heat C of a well-annealed alloy V-5 at.% Ta, measured at $1.4 \leq T \leq 5$°K in steady magnetic fields, displays sharp, bulk, superconducting transitions at upper critical fields $H_{c2}$ a factor ≈10 larger than the calorimetrically derived thermodynamic critical fields $H_c$. The transitions are similar to those observed in $V_3Ga$, but in this case it is unlikely that the bulk nature of the high-field transitions can be attributed to a nearly complete occupation of the specimen volume by dislocation-centered high-field superconducting filaments of diameter comparable to the penetration depth, since electron transmission microscopy studies on an identically prepared specimen indicate that in at least 95% of the specimen volume the mean separation between dislocations is greater than $1.4 \times 10^{-4}$ cm. However, the data are explicable on the basis of the Ginzburg-Landau-Abrikosov-Gor'kov theory with a parameter $\kappa \approx H_{c2}/\sqrt{2}H_c \approx 7$. The transition specific heat jumps $\Delta C(T_s)/\gamma T_s = 1.44, 1.15, 1.10, 0.94$ occur at $T_s = 4.30, 4.09, 3.85, 3.37$°K in fields H = 0, 1, 2, 4 kG, respectively, where $\gamma \equiv$ normal state electronic specific heat coefficient = 9.20 mJ/mole (K°)$^2$. The $\Delta C(T_s)$ values are in fair agreement with those calculated via Ehrenfest's equation for second-order phase transitions using Abrikosov's theoretical value of $(\partial I/\partial H)_T$ at $T_s$ for $\kappa = 7$, where I ≡ magnetization. For $(T_s/T) \geq 1.8$, $C_{es}/\gamma T_s = a \exp(-bT_s/T)$ with a = 8.95, 6.24, 5.01, 4.7; b = 1.48, 1.28, 1.17, 1.1; for H = 0, 1, 2, 4 kG, respectively, where $C_{es}$ is the electronic contribution to the specific heat. The exponential temperature dependence of $C_{es}$ down to 1.4°K suggests an essentially everywhere finite, field-dependent, high-field energy gap in accord with Abrikosov's vortex model. (auth)

**7650** MAGNETIC FIELD DEPENDENCE OF THE ENERGY GAP IN SUPERCONDUCTORS AT FINITE TEMPERATURE. Toshio Tsuzuki (Osaka Univ.). Progr. Theoret. Phys. (Kyoto), 30: 569-71(Oct. 1963).

Previous calculations on the decrease of the energy gap at zero temperature for a bulk superconductor in the presence of a static external magnetic field to the second order in the field strength are extended to the case of finite temperatures. (C.E.S.)

**7651** JOSEPHSON EFFECT IN SUPERCONDUCTIVE TUNNELLING. Kazumi Maki (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 30: 573-5(Oct. 1963).

The Ginzburg-Landau equation is used to investigate the Josephson effect in superconductive tunnelling in which condensed electron pairs tunnel through the barrier. (C.E.S.)

**7652** FLUXOID QUANTIZATION IN A MULTIPLY-CONNECTED SUPERCONDUCTOR. R. D. Parks and W. A. Little (Stanford Univ., Calif.). 31p. (CONF-22-29).

From American Physical Society, 1963 Annual Meeting, New York, Jan. 1963.

The transition temperatures of thin-walled superconducting hollow cylinders of very small diameters (approximately one micron) were measured as a function

of the applied magnetic field in the axial direction. Oscillations with a period of hc/2e in the magnetic flux through the cylinder were observed in the transition temperature $T_c$. This is a consequence of fluxoid quantization, which was originally predicted by Fritz London. The basic unit of magnetic flux hc/2e is explained in terms of London's original arguments and the result from the BCS theory that the charge carriers in a superconductor are pairs of electrons. Measurements were made on Sn, In, Pb, Al, and Sn–In alloys. A periodicity in the magnetic flux of hc/2e was observed in all of the samples. The amplitude of $\Delta T_c$ varied from approximately $10^{-5}$ to $10^{-3}$°K and depended upon the temperature, the radius, and the mean free path of the cylindrical sample. (auth)

**7653** NUCLEAR MAGNETIC RESONANCE AND RELAXATION IN SUPERCONDUCTING VANADIUM. R. J. Noer and W. D. Knight (Univ. of California, Berkeley). 30p. (CONF-301-23)

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

Following a preliminary report that the nuclear resonances in normal and superconducting vanadium were observed to be the same, a number of further specimens of varying thickness were prepared and studied. The principal aims were to establish that the specimen superconducts throughout its volume and to determine accurately the nuclear resonance frequencies, intensities, widths, and relaxation rates. Three specimens of thin films were investigated. The thicknesses were 500, 200, and 100 Å, respectively; the critical temperatures (at zero field) ranged from 4.5 to 2.8°K; the critical fields (at zero temperature) ranged from 25 to 80 kilooersteds. The films were evaporated on mylar sheets at pressures less than $10^{-6}$ mm Hg. The resistance ratio between 4°K and room temperature was 3/1. The resistances of several films, selected at random from each sample, were determined in separate direct experiments. The critical temperatures determined in this way were consistent with the corresponding values derived from the diamagnetic susceptibilities measured for the complete samples in the resonance apparatus. The significant findings in the temperature range between $0.4\ T_c < T > T_c$ are: the nuclear resonance center frequency varies by less than 2 parts in $10^4$; the line width increases by an amount that is consistent with the field inhomogeneity attributable to the partial Meissner effect; the nuclear spin relaxation rate is strictly proportional to absolute temperature. Since the results do not show some of the effects usually associated with a sharply defined energy gap in superconductors, the energy gap model for thin films of hard superconductors is examined, and relevant hyperfine interactions associated with s-states in the conduction band, the exchange polarization of the core electrons, and the orbital paramagnetism are reexamined. (auth)

**7654** IMPROVEMENTS IN OR RELATING TO REFRIGERATORS. Heinz London (to United Kingdom Atomic Energy Authority). British Patent 945,223. Dec. 23, 1963. Filed Sept. 22, 1961.

A refrigerator is designed for operating at and maintaining a temperature lower than can be obtained by evaporation of $He^3$ (0.3°K). In this refrigerator, a volume of liquid $He^3$ is continuously diluted with liquid $He^4$, heat being absorbed from a load to provide the heat of mixing. $He^3$ is distilled from the mixture to maintain the $He^3$ concentration below the equilibrium concentration, and the distilled $He^3$ is subsequently recycled for remixing. Several embodiments of the refrigerator are described. (D.L.C.)

## Neutron Physics

**7655** (AAEC/TM-224) NUMERICAL SOLUTION OF THE DOUBLE $P_3$ EQUATIONS IN SLAB GEOMETRY. J. J. Thompson (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Nov. 1963. 8p.

The numerical solution of the double $P_3$ equations in slab geometry, by a forward-elimination back-substitution process, is described and is illustrated by application to a slab self shielding problem and by comparison with the results obtained by analytical solution of the equations. (auth)

**7656** (AE-125) MEASUREMENT OF THE SLOWING-DOWN AND THERMALIZATION TIME OF NEUTRONS IN WATER. E. Moeller and N. G. Sjoestrand (Aktiebolaget Atomenergi, Stockholm). Nov. 1963. 51p.

The experimental equipment for the study of the time behavior of neutrons during slowing-down and thermalization in a moderator by the use of a pulsed van de Graaff accelerator as a neutron source is described. The change with time of the neutron spectrum is obtained from its reaction with spectrum indicators, the reaction rate being observed by capture gamma detection. The time resolution may be chosen in the range 0.01 to 5 μsec. Measurements were made for water with Cd, Gd, and Sm as indicators dissolved in the medium. A slowing-down time to 0.2 ev of 2.7 ± 0.4 μsec and a total thermalization time of 25–30 μsec were obtained. From 9 μs after the injection, the results are well described by the assumption of the flux as a Maxwell distribution cooling down to the moderator temperature with a thermalization time constant of 4.1 ± 0.4 μsec. (auth)

**7657** (AEEW-R-161) SOME IMPROVEMENTS IN THE DISCRETE ORDINATE METHOD OF B. G. CARLSON FOR SOLVING THE NEUTRON TRANSPORT EQUATION. J. R. Askew and R. J. Brissenden (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Aug. 1963. 41p.

An account is given of the DSN method for simulating neutron transport, together with methods of solution developed to deal with problems in the physics of thermal reactors, for which previously available computer programs were unsatisfactory. The methods described are those incorporated in the programs WINFRITH DSN written in FORTRAN language for the IBM 7090 and STRETCH computers. (auth)

**7658** (BNL-7550) TWO LECTURES ON THE MAGNETIC SCATTERING OF NEUTRONS. M. Blume (Brookhaven National Lab., Upton, N. Y.). Sept. 1963. Contract AT(30-1)-Gen-16. 17p.

The usefulness of neutron diffraction for the study of magnetic solids is outlined. The appropriate theory for elastic scattering by ferromagnets and inelastic scattering by spin waves in ferromagnets is briefly presented, and the information that can be obtained from these types of scattering is indicated. (D.C.W.)

**7659** (CONF-187-27) APPLICATION OF THE VARIATIONAL METHOD TO THE CALCULATION OF THE TIME DEPENDENCE OF THE NEUTRON FLUX IN SMALL PULSED SLABS, CYLINDERS AND SPHERES. F. D. Judge and P. B. Daitch (Rensselaer Polytechnic Inst., Troy, N. Y.). [nd]. Contract W-31-109-eng-52. 20p.

From American Nuclear Society Meeting, New York, Nov. 1963.

The variational method is applied to the monoenergetic time dependent transport equation to obtain a simple relation for the asymptotic decay constant in small pulsed assemblies. The results indicate that flat trial functions may be a reasonable representation of the flux distributions in the thin slab limit. This approach is superior to many of the usual transport approximations. (auth)

**7660** (EUR-479.e) NEUTRON DISTRIBUTION IN A CRITICAL SLAB BY THE MULTIPLE COLLISION METHOD. T. Asaoka (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy); Y. Nakahara, and K. Saito (Japan Atomic Energy Research Inst., Tokyo). 1963. 47p.

The detailed distribution of monoenergetic neutrons, in a critical slab with finite thickness, is obtained analytically by the multiple collision method. Under the assumption that the scattering of neutrons is spherically symmetric in the L system, the vector flux or the angular-space distribution of neutrons is obtained in the form of an infinite series of the spherical Bessel functions, from which the scalar flux and the net current are easily derived. This gives definitely the discontinuity of the angular distribution at the boundary of the slab. Further, this infinite series converges fast and hence the accurate result can be obtained readily by truncating the sum at the first few terms, especially for the thinner slabs. In the course of the formulation, the critical condition is also derived and is shown to coincide with the one obtained previously. Numerical examples are given and discussed. The correspondence of the formulation to the usual transport equation is demonstrated. (auth)

**7661** (HW-77954(p.4.78-84)) EFFECT OF EPITHERMAL FISSIONS IN $U^{235}$ WHEN USING URANIUM AS A FAST FLUX MONITOR. P. R. Prevo and R. E. Dahl (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

If cadmium-covered natural uranium is used to monitor fast neutron flux, errors of from 40 to 80% can result if it is assumed that the fissions are due entirely to $U^{238}$. Errors on the order of 40% are typical of irradiations performed in a hard spectrum such as found in the fuel region of a reactor. The 80% figure applies to well-moderated spectra. These uncertainties can be reduced by using depleted uranium. By using uranium with $U^{235}$ concentrations of 0.1 and 0.015%, respectively, the errors stated above are reduced to ~10%. (auth)

**7662** (ORNL-3499(Vol.II)) NEUTRON PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING AUGUST 1, 1963. (Oak Ridge National Lab., Tenn.). Dec. 18, 1963. Contract W-7405-eng-26. 152p.

Separate abstracts were prepared for twenty-seven of the thirty sections of the report. (D.C.W.)

*For abstracts of individual sections see: 6714, 6715, 7050, 7051, 7052, 7053, 7054, 7055, 7056, 7360, 7361, 7362, 7363, 7473, 7474, 7689, 7690, 7691, 7692, 7693, 7694, 7840, 7841, 7842, 7843, 7844, and 7845.*

**7663** (TID-19819) AN INVESTIGATION OF EQUIVALENT RADII FOR $P_3$ CALCULATIONS IN STRONG ABSORBERS (thesis). Larry Dean Noble (Kansas State Univ., Manhattan. Engineering Experiment Station). 1964. 104p. Kansas State Univ. Eng. Expt. St., Spec. Rept. No. 39.

The possibility of using a fictional equivalent rod radius to accurately predict the neutron flux depression in strong absorbers by the use of the $P_3$ approximation to the Boltzmann equation for monoenergetic neutron transport was studied. The theory, appropriate boundary conditions, and the required computer programs were developed for determining the equivalent rod radius from experimental measurements in assemblies having exponential flux dependence in the z-direction. Preliminary experimental results indicate that good equivalent radii can be determined. (auth)

**7664** (TID-19909) ONE-SPEED TRANSPORT STUDY OF FAST NEUTRON PULSES IN NON-MODERATING MEDIA (thesis). Robert G. Cockrell, R. B. Perez, and G. R. Dalton (Florida. Univ., Gainesville). [1963]. Contract AT(40-1)-2097. 33p.

Thesis by Robert G. Cockrell.

The one-speed, time-dependent, source-free Boltzmann integro-differential neutron transport equation is used to study the time dependence of monoenergetic neutrons in a spherical, homogeneous medium. By applying the Marshak boundary condition at the outer face instead of the usual vanishing of the scalar flux at some extrapolated boundary, two coupled characteristic equations are derived that relate the time constants and space eigenvalues of the sphere in terms of its geometric radius and the nuclear parameters of the medium. Tables and graphs of the fundamental space eigenvalue and time constant are given for 0.82 and 1.24 Mev neutrons in lead. Numerical values of the time constant as a function of the size of the system are compared for several $P_N$ approximations ranging from $P_1$ to $P_{15}$. The results of fitting experimental data with the characteristic equation of the $P_7$ approximation compare favorably with other published values. A method is given for determining the angular moments of a Legendre polynomial expansion of the scattering kernel from pulsed neutron data. (auth)

**7665** TIME DEPENDENT NEUTRON SPECTRA IN GRAPHITE. E. Barnard, N. A. Khan, R. C. F. McLatchie, M. J. Poole, and J. H. Tait (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Sci. Eng., 17: 513-22(Dec. 1963).

An experiment is described in which the 28-Mev electron linac at Harwell was used as a neutron source to produce 1 μsec bursts of $10^{11}$ electrons 160 times per second. A natural uranium target was placed centrally against one face of a 60 × 62.2 × 71.1 cm graphite block, and a neutron beam extracted from a channel running into the center of the block. This beam was interrupted by a slow chopper running in synchronism with the pulses from the accelerator. In this way 100 μsec "time samples" of the neutrons in the block were taken and their spectrum determined by the time-of-the-flight method. The instant of the time sample relative to the fast neutron pulse could be varied by an electronic delay circuit. Neutron spectra are presented for the time varying between 300 and 1000 μsec after the pulse. These spectra differ from the Maxwellian shape but approach asymptotically to a "cooled Maxwellian" from which they are indistinguishable after 1000 μsec. Detailed calculations of the spectra were made using an IBM 7090 computer to obtain a numerical solution of the time and energy dependent diffusion equation using a scattering kernel based on the scattering measurements made at Chalk River. The experimental results are also compared with spectra using a scattering kernel based on the heavy gas model with a fictitious mass of 33. (auth)

**7666** EVALUATION OF THE DOPPLER-BROADENED SINGLE-LEVEL AND INTERFERENCE FUNCTIONS.

T. D. Beynon (Woolwich Polytechnic, [Eng.]) and I. S. Grant. Nucl. Sci. Eng., 17: 547-50(Dec. 1963).

Two methods of calculating Doppler-broadened resonance cross sections are described. Both methods use series expansions suitable for use in a digital computer. Tables of the single-level and interference functions are given which cover the range of arguments normally found in reactor calculations. (auth)

**7667** ASYMPTOTIC DISTRIBUTION OF THERMAL NEUTRON FLUX IN AN INFINITE MEDIUM OF BERYLLIUM CONTAINING A CONSTANT PLANE SOURCE. R. D. Jain (Atomic Energy Establishment, Trombay, India). Nucl. Sci. Eng., 17: 551-6(Dec. 1963).

The asymptotic energy spectrum of thermal neutrons in an infinite medium of beryllium was calculated for 300, 200, and 100°K, for a constant plane source of neutrons at the midplane. The techniques of multigroup diffusion theory were applied, using Nelkin's first order scattering kernel for Be, and the energy-dependent transport mean free path, $\lambda_{tr}(E)$, calculated by Bhandari. Because of the violent variation of $\lambda_{tr}$ in the vicinity of the Bragg cutoff energy, for the lower moderator temperatures the calculated flux spectrum is quite different from the Maxwellian. At 300°K the deviation from the Maxwellian is small. (auth)

**7668** CONSTRUCTION AND APPLICATION OF NEUTRON GENERATORS. W. Eyrick (Kernforschungszentrum Karlsruhe, Ger.). Umschau Wiss. Tech., 63: 695-7 (Nov. 15, 1963). (In German)

The three nuclear reactions producing neutrons are briefly described. The construction and operation of neutron generators using the interaction of nuclei for neutron production are discussed and illustrated. Examples of the application of these generators in science and technology are given. (J.S.R.)

**7669** DEVICE FOR THE PRODUCTION OF SHORT NEUTRON PULSES. (to Brown, Boveri & Cie, AG and Beteiligungs- und Patentverwaltungsgesellschaft mbh). French Patent 1,298,077. May 28, 1962. Priority date Nov. 25, 1960, Germany.

A subcritical quantity of highly enriched fissile material is mixed with a moderator and disposed within a fluid-tight vessel, while a duct passes through both the mass of this material and the vessel. For producing short neutron pulses of high intensity, a given quantity of additional fissile material is passed with a given velocity through the duct so that this additional quantity forms, during its passage, a supercritical system. Preferably this additional quantity moves through the duct only under the influence of gravity. According to another embodiment, the additional quantity may be accelerated or slowed down by a pressurized fluid. (IIB)

## Nuclear Properties and Reactions

**7670** (AD-423292) NUCLEAR MAGNETIC RESONANCE IN TRANSITION METAL–ALUMINUM INTERMETALLIC COMPOUNDS. Technical Report No. 6. Kenneth R. Atkins, Jerold Alan Seitchik, and Roger H. Walmsley (Pennsylvania. Univ., Philadelphia). [1962]. Contract Nonr 551(28). 158p.

The $Al^{27}$ Knight shifts in NiAl, CoAl, FeAl, and $Ni_3Al$ and the $Co^{59}$ shift in CoAl were determined as a function of temperature and magnetic field. Each shift was found to be independent of magnetic field. $Co^{59}$ in CoAl and $Al^{27}$ in FeAl exhibited large, temperature-dependent shifts. The $Al^{27}$ shifts in NiAl, CoAl, and $Ni_3Al$ were temperature-independent and small compared to the Knight shift in pure Al metal. The results are interpreted in terms of the magnetic structure of the alloys. (D.L.C.)

**7671** (AWRE-NR-6/63) SECONDARY NEUTRON SPECTRA FROM NEUTRON-INDUCED REACTIONS WITH Li-6 AND Li-7. R. Batchelor and J. H. Towle (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Dec. 1963. 8p.

The secondary neutron energy spectra, observed during studies of the neutron interactions with lithium isotopes using a time of flight spectrometer, are reproduced and discussed briefly. (auth)

**7672** (CONF-30-6) 2π-DIFFERENTIAL RECOIL STUDY OF THE $Cu^{65}(p,pn)Cu^{64}$ REACTION. D. J. Reuland, N. K. Ganguly, and A. A. Caretto, Jr. (Carnegie Inst. of Tech., Pittsburgh). [1963]. Contract [AT(30-1)-1825]. 29p.

From American Physical Society 1962 Winter Meeting in the West, Stanford, Calif., Dec. 1963.

The 2π-differential recoil range of the $Cu^{65}(p,pn)Cu^{64}$ reaction was determined with incident protons of 130 and 396 Mev. The number of $Cu^{64}$ atoms that recoiled from Cu targets about 10 $\mu g/cm^2$ thick and caught in Al absorbers of varying thickness from about 10 $\mu g/cm^2$ to about 180 $\mu g/cm^2$ was determined. The resulting integral recoil distribution at 396 Mev indicates that there are two groups of recoiling $Cu^{64}$ nuclei. The short range group has a maximum range of about (45 ± 5) $\mu g/cm^2$ of Al, and the long range group has a maximum range of about (180 ± 8) $\mu g/cm^2$ of Al. At 130 Mev only one recoil range was observed, which has a maximum range of about (50 ± 5) $\mu g/cm^2$ of Al. The angular distribution of the recoiling $Cu^{64}$ nuclei was also determined using a 10 $\mu g/cm^2$ Cu target and thick Al catcher foils. The short range $Cu^{64}$ recoils were interpreted in terms of an inelastic (p,p′) scattering mechanism followed by neutron evaporation. The long range recoils can be interpreted in terms of the knock-out mechanism. The relative number of events taking place by these two mechanisms is about equal. Reasonable agreement is obtained between predictions based on the two mechanisms and the experimental observations. (auth)

**7673** (CONF-187-26) EVALUATION OF RESONANCE CAPTURE APPROXIMATIONS. K. R. Edgar (Knolls Atomic Power Lab., Schenectady, N. Y.). Nov. 21, 1963. Contract W-31-109-eng-52. 17p.

From American Nuclear Society Meeting, New York, Nov. 1963.

The program KRUDE, which solves the slowing down and adjoint equations for a mixture of resonance and nonresonance isotopes in an infinite homogeneous medium, was used to evaluate some resonance capture approximations (variational and successive) that use linear combinations of narrow and wide resonance fluxes. Results obtained for resonance capture in the 291-ev resonance of $Zr^{91}$ and the 192-ev resonance of $U^{238}$ are compared, and three methods for including Doppler effects in the variational method are considered. (D.C.W.)

**7674** (CONF-327-7) SPATIAL DISTRIBUTION OF THE ABSORPTIVE INTERACTION FOR LOW-ENERGY NUCLEONS. P. A. Moldauer (Argonne National Lab., Ill.). [1963]. Contract W-31-109-eng-38. 6p.

From Topical Conference on Compounds Nuclear States, Gatlinburg, Tenn., Oct. 1963.

It is shown that the predictions of the optical model regarding the scattering and absorption of low energy neu-

trons are quite sensitive to the spatial distribution of the absorption potential W for the nucleon and that an analysis of available data suggests that at neutron binding energy in heavy nuclei W is still quite small in the nuclear interior and peaks sharply just outside the surface. Further information on the spatial distribution of W can be obtained by determining the widths of the distributions of single particle state characteristics among nuclear levels below the neutron threshold. The results of high resolution stripping and gamma-ray scattering experiments on such levels tend to support the evidence from neutron absorption. (auth)

**7675** (CONF-327-8) POLARIZATION OF NEUTRONS SCATTERED FROM $Be^9$; PARITIES OF 7.37- AND 7.54 Mev STATES IN $Be^{10}$. R. O. Lane, A. J. Elwyn, and A. Langsdorf, Jr. (Argonne National Lab., Ill.). [nd]. Contract W-31-109-eng-38. 6p.

From Topical Conference on Compounds Nuclear States, Gatlinburg, Tenn., Oct. 1963.

The polarization and differential cross section for neutrons scattered from $Be^9$ were measured at five angles for incident neutron energies from 0.2 to 2.0 Mev. Analysis of the experimental data indicates that $J^\pi$ is most probably $3^-$(l=2) for the 7.37-Mev state and $2^+$(l=1) for the 7.54-Mev state. (D.C.W.)

**7676** (CONF-340-3) OPTICAL-MODEL ANALYSIS OF NEUTRON SCATTERING FROM NUCLEI NEAR A = 100 AT LOW ENERGIES. J. E. Monahan, A. J. Elwyn, R. O. Lane, and A. Langsdorf, Jr. (Argonne National Lab., Ill.). [1962]. Contract [W-31-109-eng-38]. 45p.

From American Physical Society 1963 Autumn Meeting, Chicago, Oct. 1963.

The polarization and differential cross sections for neutrons scattered from Zr, Nb, Mo, and Cd were measured at five angles for neutron energies between 0.275 and 0.85 Mev. The results were analyzed in terms of a local optical model equivalent to the nonlocal model of Perey. The analysis leads to the following major conclusions: the calculations, corrected for the effects of compound elastic scattering, are consistent with most of the observed scattering data, particularly when a spin-orbit potential that includes both a real and imaginary term of the Thomas type is employed; and calculations (based on this model) of the magnitude and shape of the P-wave neutron strength function in the region near A = 100 are not very sensitive to the parameters of the spin-orbit potential — at least when the real term is between 7 and 20 Mev and the imaginary term is between 0 and 7 Mev. (auth)

**7677** (CONF-340-6) POLARIZATION OF NEUTRONS SCATTERED FROM F, Na, Al, AND P. A. J. Elwyn, R. O. Lane, and A. Langsdorf, Jr. (Argonne National Lab., Ill.). [nd]. Contract W-31-109-eng-38. 12p.

From American Physical Society 1963 Autumn Meeting, Chicago, Oct. 1963.

The polarization and differential cross section for neutrons scattered from samples of $F(CF_2)$, Na, Al, and P were measured at five angles for energies between 0.25 and 2.2 Mev. The source of polarized neutrons was the $Li^7(p,n)Be^7$ reaction with the neutrons emitted at 51° with respect to the incident proton beam. The thickness of the evaporated Li targets was determined to be 100 to 150 kev (to 1.9-Mev protons). Polarization was measured by determining the difference between the scattered intensity without a magnetic field and the intensity when the neutrons incident on the scatterer were passed through the transverse field of an electromagnet set to precess the spins through 180°. The angular dependence of the polarization changes quite rapidly as a function of energy for all four nuclei. Both the total cross sections and differential cross sections show fluctuations as a function of energy throughout the range of energies utilized. Attempts to fit the data in terms of a local optical model equivalent to the nonlocal model of Perey were not very successful. (auth)

**7678** (CONF-346-5) OPTICAL MODEL INTERPRETATION OF NEUTRON STRENGTH FUNCTIONS. P. A. Moldauer (Argonne National Lab., Ill.). [1963]. Contract W-31-109-eng-38. 12p.

From International Conference on Nuclear Physics with Reactor Neutrons, Argonne, Ill., Oct. 1963.

The qualitative dependence of the neutron strength function upon optical model parameters is discussed with emphasis on the effects of variations in the magnitude and spatial dependence of the absorptive potential. A model is presented that gives a good account of strength functions and potential scattering radii, as well as neutron scattering cross sections below 1 Mev for spherical nuclei. (auth)

**7679** (CONF-346-6) COHERENT NUCLEAR SCATTERING AMPLITUDES AND CROSS SECTIONS AS DETERMINED BY NEUTRON DIFFRACTION TECHNIQUES. M. H. Mueller, S. S. Sidhu, L. Heaton, R. L. Hitterman, and H. W. Knott (Argonne National Lab., Ill.). Oct. 3, 1963. Contract W-31-109-eng-38. 5p.

From International Conference on Nuclear Physics with Reactor Neutrons, Argonne, Ill., Oct. 1963.

The diffraction techniques used at ANL to obtain scattering amplitudes and cross sections for elements and isotopes are briefly described; and some results obtained for Zr, $Tc^{99}$, Os, $Os^{188}$, $Os^{189}$, $Os^{190}$, $Os^{192}$, K, $K^{39}$, Rb, $Rb^{85}$, Ir, and Mg are summarized. (D.C.W.)

**7680** (KFK-120(Pt.III)) NEUTRON CROSS SECTIONS FOR FAST REACTOR MATERIALS. PART III. GRAPHS. J. J. Schmidt (Kernforschungszentrum. Institut für Neutronenphysik und Reaktortechnik, Karlsruhe, Germany). Dec. 1962. 335p. (EANDC-E-35-U(Pt.III))

Neutron cross sections and neutron nuclear data for H, He, $C^{12}$, $O^{16}$, $Na^{23}$, Cr, Fe, Ni, Mo, $U^{235}$, $U^{238}$, and $Pu^{239}$ are plotted as functions of the incident neutron energy in the range from 0.01 ev to 10 Mev. (D.C.W.)

**7681** (NP-13415) ISOMERIC STATE OF $Sn^{115}$ EXCITED BY THE $In^{115}(p,n)$ REACTION. E. Ivanov, A. Alevra, D. Plostinaru, N. Martalogu, and R. Dumitrescu (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). June 1963. 25p.

Using a pulsed beam technique, a short-lived isomeric state of $Sn^{115}$($T_{\frac{1}{2}}$ = 159 ± 1 μsec) was excited; and its decay properties were investigated. Three gamma-rays of 107-, 120-, and 500-kev energy of the same half life were found, indicating that the isomeric state decays by a triple cascade. The last two gamma rays were coincident. K-shell and total internal conversion coefficients were determined for the 107- and 120-kev transitions by measuring the yields of both singles and gamma-gamma coincidence spectra. The values obtained are consistent with an M2 transition of 107-kev and an E2 transition of 120-kev energy. A scheme for the first excited states of $Sn^{115}$ is proposed, and a comparison with the pairing plus quadrupole force calculation of Kisslinger and Sorensen is made. (auth)

**7682** (NP-13418) ANGULAR DISTRIBUTION OF NEUTRONS POLARIZATION FROM THE $Li^7(p,n)Be^7$ FOR $E_p$ = 4.5 Mev. I. Minzatu, A. Calboreanu, N. Martalogu, R. Dumitrescu, and M. Molea (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). Mar. 1963. 11p.

The polarization of neutrons was analyzed by elastic scattering on carbon. A time-of-flight method was used to detect the neutrons and select them according to energy. The angular distribution obtained is similar to that for the $T(p,n)He^4$ reaction, indicating that Li has the previously proposed cluster structure. It is concluded that direct interaction as well as compound nucleus formation contributes to the neutron polarization. Also, the incident proton seems to interact only with one of the neutrons in the $P_{\frac{1}{2}}$ shell of the Li nucleus. (D.C.W.)

**7683** (NP-13419) LEVEL DENSITIES IN TWO La ISOTOPES FROM $Ba^{137}(p,n)La^{137}$ AND $Ba^{138}(p,n)La^{138}$ REACTIONS. M. T. Magda, I. S. Vîlcov, E. Truţia, I. R. Lukas, N. Martalogu, and M. Molea (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). Mar. 1963. 10p.

The neutron evaporation spectra resulting from the reactions were measured by the time-of-flight method, and the nuclear level densities in the two isotopes were determined from them. The densities obtained are in agreement with values obtained for similar isotopes and confirm the existence of a marked minimum at A = 140 and of large level spacings at nuclei with neutron numbers below 82. (D.C.W.)

**7684** (NP-13420) RESEARCH WORK IN THE FIELD OF NUCLEAR PHYSICS AT THE VVR-S REACTOR IN RUMANIA. M. Petraşcu (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). Sept. 1963. 10p.

Nuclear levels were investigated by angular correlation and coincidence measurements on neutron capture gamma rays, and the total neutron cross sections of some As, Pd, and Ca isotopes were measured in the energy range from 0.01 to 0.1 ev. Sources of background related with the $(n,\gamma)$ reactions were also studied, and a thermal neutron spectrum measured in a horizontal reactor channel indicates a temperature of 390 ± 17°K in the reactor. (D.C.W.)

**7685** (NP-13421) ON BARRIER PENETRABILITIES IN ALPHA DECAY. Aurel Sandulescu (Academia R. P. R. Institutul de Fizică Atomică, Bucharest) and Tibor Voeroes (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). Aug. 1963. 9p.

The barrier penetrabilities for some nuclei were calculated by numerical integration in the WKB approximation, assuming nuclear coulombian and centrifugal potentials for both even-even and odd nuclei. The relative intensities of favored alpha transitions for five odd nuclei were calculated by using the intensities of favored alpha transitions of the corresponding five even-even nuclei. The theoretical results are in good agreement with the experimental data. (auth)

**7686** (NP-13422) ALPHA-REDUCED WIDTHS ON SUPERFLUID MODEL. A. Sandulescu (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). May 1963. 12p.

Explicit expressions for the reduced widths of alpha transitions on rotational bands of intrinsic states are derived on the basis of the superfluid model. (auth)

**7687** (NP-13427) THE ROLE OF PARTICLE-HOLE CORRELATION IN THE INELASTIC SCATTERING OF ELECTRONS FROM $C^{12}$, $O^{16}$, AND $Ca^{40}$. Technical Report No. 13. Vincent Gillet (Carnegie Inst. of Tech., Pittsburgh) and Michel A. Melkanoff (California. Univ., Los Angeles). Sept. 1963. Contract 760(15). 37p.

All available experimental data on the inelastic scattering of high energy electrons from $C^{12}$, $O^{16}$, and $Ca^{40}$ were analyzed in terms of the particle-hole models of nuclear excitations. The calculations do not involve any free parameters. The results proved quite sensitive to the treatment of nuclear correlations and generally favored the Random Phase Approximation, which yielded satisfactory agreement with most of the data. (auth)

**7688** (ORNL-3469) MEASUREMENT OF SPECTRAL DISTRIBUTION OF POSITRON FLUX IN AN INFINITE COPPER MEDIUM CONTAINING $Cu^{64}$ (thesis). W. H. Wilkie and R. D. Birkhoff (Oak Ridge National Lab., Tenn.). Dec. 24, 1963. Contract W-7405-eng-26. 72p.

Submitted to Vanderbilt Univ., Nashville.

The spectral distribution of the flux of positrons inside a beta radioactive medium was experimentally determined using an anthracene coincidence scintillation spectrometer. Positrons leaving a copper cavity source containing $Cu^{64}$ were absorbed in a thin anthracene crystal. The light pulse from the anthracene was recorded in a 256 channel analyzer if a NaI scintillation spectrometer nearby recorded simultaneously a count under the total absorption peak for annihilation radiation. Thus, discrimination against negative and secondary electrons was obtained which permitted observation of the primary positron slowing down flux. Data were corrected for the non-linear pulse height vs energy relationship in anthracene by a semi-empirical theory due to Birks, the validity of which was demonstrated by its use in obtaining a linear Fermi plot of $Pm^{147}$. Positron spectra were corrected also for Compton absorption of the annihilation radiation in the anthracene. Results were compared with the theoretical continuous-slowing-down model. Over the energy range measured (20–650 kev) it was concluded that the continuous-slowing-down model gives the correct shape for the primary slowing-down spectrum. 43 references. (auth)

**7689** (ORNL-3499(Vol.II)(p.31-53)) PARAMETRIC STUDY OF CALCULATED CASCADE AND EVAPORATION REACTIONS FOR 25- TO 400-Mev NUCLEONS INCIDENT ON COMPLEX NUCLEI. H. W. Bertini (Oak Ridge National Lab., Tenn.).

The study covered 50-, 200-, and 400-Mev protons incident on $C^{12}$, $Al^{27}$, $Cu^{65}$, and $Pb^{207}$ and neutrons incident on $Al^{27}$ at the same energies. Excitation energy distributions of the residual nucleus resulting from cascade reactions, the average number of emitted cascade nucleons per inelastic collision, normalized cascade and evaporation particle spectra, and angular distributions of emitted cascade nucleons were considered. In addition, comparisons of calculated and experimental radiochemical cross sections were made. (auth)

**7690** (ORNL-3499(Vol.II)(p.54-6)) LITERATURE SURVEY OF NONELASTIC NUCLEON AND PION REACTIONS WITH COMPLEX NUCLEI. H. W. Bertini (Oak Ridge National Lab., Tenn.).

Abstracts in Physics Abstracts are examined for literature on neutron yields and cross sections for particle-particle reactions and for meson ($\pi$) and secondary nucleon production in meson ($\pi$) and nucleons reactions with complex nuclei at 20 Mev to 30 Bev. A typical page from a previously issued report is included. (D.C.W.)

**7691** (ORNL-3499(Vol.II)(p.63-6)) A PROPOSED NOMENCLATURE SCHEME FOR EXPERIMENTAL HIGH-ENERGY NUCLEAR CROSS SECTIONS. C. D. Zerby and H. Goldstein (Columbia Univ., New York).

A set of rules previously formulated for low-energy nuclear cross-section terminology and associated notation was modified and extended to include high-energy radiations. (auth)

**7692** (ORNL-3499(Vol.II)(p.66-72)) SPECTRA OF GAMMA RAYS PRODUCED BY THE INTERACTION OF ~160-Mev PROTONS WITH Be, C, O, Al, Co, AND Bi. W. Zobel, F. C. Maienschein, and R. J. Scroggs (Oak Ridge National Lab., Tenn.).

The photon spectra were measured with two multiple-crystal scintillation spectrometers. Time-of-flight requirements aided in the rejection of neutron-induced backgrounds. Pulse-height spectra and one analyzed spectrum are presented. Cross sections for gamma production at specified energies are also included. (auth)

**7693** (ORNL-3499(Vol.II)(p.73-84)) DIFFERENTIAL SECONDARY-NUCLEON CROSS SECTIONS BY FLIGHT-TIME SPECTROSCOPY FOR REACTIONS OF 160-Mev PROTONS WITH NUCLEI. R. W. Peelle, T. A. Love, N. W. Hill, R. L. Cowperthwaite, and R. T. Santoro (Oak Ridge National Lab., Tenn.).

Time-of-flight spectra were obtained at several angles for secondary neutrons and protons resulting from reactions of 160-Mev protons with Bi, Pb, Co, Cu, Al, C, Be, $D_2O$, and $H_2O$. The experimental apparatus and procedures and the status of the analysis are discussed. Proton spectra are shown, and the cross sections for the production of secondary protons from Co illustrate the softening of the spectrum at large scattering angles. (auth)

**7694** (ORNL-3499(Vol.II)(p.89-93)) NEUTRON AND PROTON SPECTRA FROM TARGETS BOMBARDED BY 160-Mev PROTONS. J. W. Wachter, W. A. Gibson, W. R. Burrus, and C. F. Johnson (General Dynamics/Fort Worth. Div. of General Dynamics Corp. Nuclear Research and Development Lab., Fort Worth, Tex.).

The spectra of neutrons and protons from proton reactions with $H_2O$, $D_2O$, Be, C, Al, Co, Cu, and Bi were measured with proton-recoil spectrometers. The method used to calculate energy spectra from the pulse-height distributions obtained is described, and typical spectra for Al, Be, and Bi are presented. (auth)

**7695** (ORNL-3525) TABLES OF FERMI INTEGRALS AND THE MULTIPOLE MOMENTS OF A ROUNDED CHARGE DISTRIBUTION. L. W. Owen and G. R. Satchler (Oak Ridge National Lab., Tenn.). Jan. 13, 1964. Contract W-7405-eng-26. 48p.

Tables of numerical values are given for the integrals $\int t^n f(t)dt$, $\int t^n (df/dt)dt$, and $\int t^n (df^2/dt^2)dt$ over the Fermi function $f(t) = [1 + \exp(t-k)]^{-1}$. They are presented in a form suitable for use in evaluating the various multipole moments of the rounded charge distributions of nuclei, both explicitly and in terms of the radii of equivalent uniform distributions that have the same moments. Analytic expressions for the integrals are discussed. (auth)

**7696** (ORNL-TM-761) NUCLEAR CROSS SECTION PROGRAM AT ORNL, AUGUST 1, 1963–JANUARY 2, 1964. H. B. Willard (Oak Ridge National Lab., Tenn.). Jan. 8, 1964. Contract W-7405-eng-26. 16p.

Papers (34) covering the cross section activities for the period are cited. Abstracts are included for several of the papers. (D.C.W.)

**7697** (TID-19931) NUCLEAR REACTION STUDIES. Annual Report, January 9, 1963–January 9, 1964. Robert L. Wolke (Pittsburgh. Univ., Wherrett Lab. of Nuclear Chemistry). Contract AT(30-1)-2771. 47p.

The equilibrium charge-state distributions of $C^{12}$ ions with velocities between 8.77 and $9.77 \times 10^8$ cm/sec and of $C^{13}$ ions with velocities between 7.08 and $8.46 \times 10^8$ cm/sec were determined. The ions were produced as recoils from $C^{12}(d,d')$ and $C^{12}(d,p)$ reactions at 15 Mev, equilibrated during the process of escaping from C targets, subjected to magnetic analysis, and detected with a low-resistivity Si surface barrier detector. The data join smoothly to previous results for higher velocities. A range-energy curve for $B^{10}$ recoil ions from the $C^{12}(d,\alpha)$ reaction showed a wide divergence from expectations. Techniques were developed for measuring absolute cross sections and isomer ratios for (d,p) reactions, and a computer program for computing these quantities from the data was written. Results for $Y^{89}(d,p)Y^{90}$ are presented. The $Si^{30}(d,\gamma)P^{32}$ and $Ba^{138}(d,\gamma)La^{140}$ reactions were also studied, and a partial excitation curve for the $W^{186}(d,2n)Re^{186}$ reaction was obtained. Calibrations of scintillation counters (NaI) and end-window proportional counters were performed. (D.C.W.)

**7698** (UCRL-11028) THE STRUCTURE OF HEAVY NUCLEI: A STUDY OF VERY WEAK ALPHA BRANCHING (thesis). Charles Michael Lederer (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 27, 1963. Contract W-7405-eng-48. 94p.

Very weak alpha branching in heavy elements was studied by a recently developed coincidence technique. This technique makes it possible to measure the energies and intensities of both $\alpha$-particle groups and de-exciting radiation, even when the transition intensities are as low as $10^{-4}$ relative to the most intense alpha group. Twenty $\alpha$-particle emitters from $Po^{214}$ to $Fm^{254}$ were examined. 0$0^+$ states (beta vibrations) were observed in six even-even nuclei, and analogous states were found in three odd-mass nuclei. They are in general characterized by low alpha-decay hindrance factors and roughly equal de-excitation by electric monopole and quadrupole transitions. However, the de-excitation of these states is in disagreement with vibrational model predictions in certain cases; more important, the de-excitation and other properties of the states exhibit some irregular variations from nucleus to nucleus which are evidence for some particle character in the states. Information was also obtained about some other types of levels. A number of 1- states (octupole vibrations) were observed, and a possible 2- state was observed in $U^{236}$. A state that appears to be analogous to the 1-octupole states of even-even nuclei was observed in $U^{235}$. In $Pu^{239}$, a $K = 3/2^+[631]$ band was identified with reasonable certainty, and numerous particle states were observed in $Bk^{249}$, although it was not possible to classify them. No 2$2^+$ states (gamma vibrations) were observed, and it appears that the alpha transitions to these states are rather highly retarded. (92 references). (auth)

**7699** (UCRL-11047) HYPERFINE STRUCTURES AND ANOMALY OF $Li^6$ AND $Li^7$, AND THE HYPERFINE STRUCTURES OF $Re^{186}$ AND $Re^{188}$ (thesis). Richard G. Schlecht (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 3, 1963. Contract W-7405-eng-48. 83p.

The atomic-beam magnetic-resonance flop-in technique was used to determine the hyperfine-structure separations and the hyperfine-structure anomaly between the isotopes $Li^6$ and $Li^7$; this technique was also used to measure the hyperfine-structure separations of the isotopes $Re^{186}$ and $Re^{188}$. The separated-oscillatory-field method of Ramsey was used to very accurately determine the hyperfine-structure separations in $Li^6$ and $Li^7$. The hyperfine-structure anomaly was determined using the separation values. The magnetic-dipole-interaction constant and the electric-quadrupole-interaction constant were measured for the two radioactive isotopes of rhenium in the $J = 5/2$ ground state. Beams were produced by electron bombardment of irradi-

ated rhenium wires. The spins of both isotopes were determined previously to be one. The nuclear moments of both isotopes were determined to be positive. An improved value for the electronic Landé g factor for rhenium was also obtained, with the result $g_J = -1.95203(8)$. (auth)

**7700** (USNRDL-TR-679) HEAVY MASS YIELDS IN THE SLOW NEUTRON FISSION OF $U^{233}$. L. R. Bunney and E. M. Scadden (Naval Radiological Defense Lab., San Francisco). Sept. 12, 1963. Contract AT(49-2)-1167. 16p.

The chain yields of masses 157, 159, and 161 in the thermal neutron fission of $U^{233}$ were determined by radiochemical methods. The last radioactive member of the mass chain was isolated, and its activity was measured relative to $Mo^{99}$. With this ratio and pertinent data from the thermal neutron fission of $U^{235}$, the mass chain yield was calculated. The chain yields are higher than was to be expected from analogy with the relative yields from thermal neutron fission of $U^{235}$ and $U^{238}$. A possible explanation is given. The chain yields of masses 91, 141, 143, 144, 147, 149, 151, and 153 in the thermal neutron fission of $U^{233}$ and $U^{235}$ were also determined in the same manner. The values, when compared to the literature values for the chain yields, provided an estimate of the accuracy of the radiochemical measurement. The accuracy is estimated to be ±10%. A new value was calculated for the chain yield of mass-157 in the thermal neutron fission of $U^{235}$. An improved value was obtained for the chain yield of mass-156 in the thermal neutron fission of $U^{233}$. (auth)

**7701** (USNRDL-TR-684) DETERMINATION OF THE HALF-LIVES OF $Pm^{143}$ AND $Pm^{144}$. L. R. Bunney and E. M. Scadden (Naval Radiological Defense Lab., San Francisco). Sept. 30, 1963. 19p.

The half lives of $Pm^{143}$ and $Pm^{144}$ were determined as 267 ± 15 day and 349 ± 16 day, respectively. Promethium-143 was produced by an $(\alpha,2n)$ reaction on $Pr^{141}$, and $Pm^{144}$ was produced by a (p,n) reaction on enriched $Nd^{144}$ (95.7%). Irradiation conditions were selected that would minimize the formation of other promethium isotopes. The decay of $Pm^{143}$ was followed on gamma-ray counters and that of $Pm^{144}$ on gamma-ray and beta-ray counters. The energies of the gamma rays emitted during the decay of these isotopes were determined from gamma-ray pulse-height distribution curves and were in agreement with the published data. (auth)

**7702** (WAPD-T-1630) MULTILEVEL EFFECTS IN NEUTRON SCATTERING AND CAPTURE CROSS SECTIONS. D. R. Harris and C. B. Noll (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Oct. 1963. Contract AT-11-1-GEN-14. 5p.

A cross section formula (RM) that involves no approximation about level spacing was compared with Feshbach's formula (FP) based on the assumption that level widths are small in comparison to level spacings and with a sum of single level formula (SSL) obtained from FP. In most practical cases FP differed from RM by less than 2%; but in artificial cases of two resonances spaced closer than their widths, both FP and SSL departed strongly from RM. (D.C.W.)

**7703** (UCRL-Trans-1002(L)) CALORIMETRICAL MEASUREMENTS OF THE ACTIVITY AND NUMBER OF GAMMA-QUANTA PER DECAY ACT. K. K. Aglintsev and E. A. Khol'nova. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Livermore) from Dokl. Akad. Nauk SSSR, 98: 357-60(1954). 9p.

Two types of calorimeters designed for measuring absolutely the intensity of $\beta$ and $\gamma$ radiations from radioactive preparations are described. Relations are included for determining the activities and the number of $\gamma$ quanta/decay. These quantities were determined for $Sb^{124}$, and the total energy of the $\beta$ and $\gamma$ radiation/$Sb^{124}$ decay was calculated to be 2.42 Mev. Measurements on $Co^{60}$ confirmed the suitability of the method of $\gamma$-quanta determination. (D.C.W.)

**7704** INVESTIGATIONS ON $\gamma$-RADIATION ACCOMPANYING THE BOMBARDMENT OF NUCLEUS Na-23 BY $\alpha$-PARTICLES OF Po. I. Angeli (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). Acta Phys. Acad. Sci. Hung., 16: 201-6(1963).

The excitation function and energy distribution of $\gamma$ radiation emitted by a metal Na-target through the effect of Po $\alpha$ particles were investigated. The obtained excitation function made it possible to determine a new highly excited level (or group of levels) of the nucleus $Al^{27}$ with certainty and another with probability. From an investigation of the $\gamma$ spectrum it was deduced that the excitation function is related to the nuclear reaction $Na^{23}(\alpha,p)Mg^{26}$. The experimental result for the reaction cross section $\sigma(\alpha,p)$ is consistent with the calculated value. (auth)

**7705** PHOTOACTIVATION OF NUCLEAR ISOMERS BY $Co^{60}$ IRRADIATION. Á. Veres (Atomic Energy Commission, Budapest). Acta Phys. Acad. Sci. Hung., 16: 261-73(1963). (In Russian)

Investigations were carried out on the isomers of 10 stable nuclides by the $A(\gamma,\gamma')A^*$ photoactivation reaction using a 1310 C $\gamma$-source. This phenomenon was not investigated until now by nuclear $\gamma$-radiation. The activation cross-section and the activation level band belonging to the transition from activated to metastable level was estimated from the extent of photoactivation measured. Some possible practical uses are suggested, based on the experimental results. (auth)

**7706** PARTIALLY PROJECTED FUNCTIONS IN THE SUPERFLUID MODEL OF A NUCLEUS. I. N. Mikhaylov (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Polon., 24: 419-25(Sept. 1963).

A new set of trial functions is suggested for solving variational problems arising in the superfluid model of a nucleus. These functions satisfy additional invariance conditions that follow from the particle-number-conservation law. From another point of view the new functions contain only a small part of these superfluous components that are present in functions of standard kind. The properties of the new functions are investigated. The energy of a system in the state described by the function that satisfies the stationary condition is found. (auth)

**7707** THE PHOTODEUTERON YIELD FROM $Cu^{63}$. J. Goldemberg, E. W. Hamburger, and A. Szily (Universidade de Sao Paulo, Brazil). Anais Acad. Brasil. Cienc., 35: 169-80(June 1963).

A 10 mg/cm$^2$ $Cu^{63}$ target is bombarded with a collimated 22-Mev bremsstrahlung beam. The target was placed at the center of a homogeneous magnetic field of circular cross section. At the periphery of the field nuclear emulsions were placed to detect the emitted charged particles. The angle of incidence of the particles in the emulsion depends on the radius of curvature of their trajectory in the magnetic field, and together with the range in the emulsion allows identification of protons and deuterons. The deuteron yield is 4.5 ± 2.5 percent of the proton yield. The alpha particle yield is also 4.5 ± 2.5 percent of the proton yield. (auth)

**7708** THE EMISSION OF LONG-RANGE $\alpha$-PARTICLES WITH $E_\alpha > 10$ Mev BY $Pu^{239}$ AND $Po^{210}$. V. N. Andreev and

S. M. Sirotkin. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1250-2 (Oct. 1963). (In Russian)

Ader in the J. Phys. et Radium 15: 60, 191(1954) and 17: 451(1956) observed the emission of $10^{-6}$ to $10^{-8}$ long-range $\alpha$ particles for each $\alpha$ decay. These $\alpha$ particles have a range of 100 to 300 $\mu$ in photoemulsions (12 to 25 Mev), and are thought to be due to spontaneous or forced triple fission. A specially constructed ionization chamber was set up to count the long-range $\alpha$ particles in the presence of ordinary $\alpha$ radiation. A 10 mg sample of $Pu^{239}$ was deposited on an aluminum disk having a density of 0.5 mg/cm$^2$, and was covered with an aluminum foil 28 $\mu$ thick. The 70 $\mu$g sample of $Po^{210}$ was electrodeposited on a nickel plate, and was covered with a tin foil 15.3 $\mu$ thick and with two aluminum foils having a total thickness of 14.4 $\mu$ in order to avoid the interference from an $(\alpha,p)$ reaction on the aluminum. The total count rates were found to be 0.55 ± 0.09 counts · hr$^{-1}$ for the $Pu^{239}$ sample, and 1.0 ± 0.1 counts · hr$^{-1}$ for the $Po^{210}$ sample for 10 to 15 Mev $\alpha$ particles. It was concluded that $Pu^{239}$ emits $<10^{-10}$ long-range $\alpha$ particles per $\alpha$ decay, and $Po^{210}$ emits $<7 \times 10^{-13}$ long-range $\alpha$ particles per $\alpha$ decay at the 95% confidence level. (TTT)

**7709** A STUDY OF THE RADIATIONS FROM $W^{187}$ (T = 24 HRS) AND FROM $Tl^{200}$ (T = 26 HRS). K. A. Baskova, S. S. Vasil'ev, M. A. Khamo-Leila, and L. Ya. Shavtvalov. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1258-60 (Oct. 1963). (In Russian)

Nuclei with a mass number of $150 < A < 190$ have deformed nuclei with a number of rotational levels. More reliable data are required for nuclei bordering this region in order to distinguish the rotational and single-particle states. A radioactive sample of $W^{187}$ was prepared by an $(n,\gamma)$ reaction, and was analyzed on a magnetic spectrometer with a thin lens. A Fermi plot showed the presence of 1325-, 635-, and 335-kev beta particles with intensities of 20, 70, and 10% respectively. The 1325-kev transition is first forbidden, since $\Delta J = 1$ and a change in parity takes place (log ft = 8). A $\beta$-$\gamma$ coincidence study showed that the 72-, 132-, and 482-kev $\gamma$ quanta were in coincidence with the 635 ± 30-kev $\beta$ transition. Radioactive $Tl^{200}$ was prepared by irradiating gold foil with 26.5-Mev $\alpha$ particles on a cyclotron by an $Au^{197}$ $(\alpha,n)Tl^{200}$ reaction, which has a threshold of 10 Mev. The positrons were counted on an end-window counter in coincidence with the counts on a gamma scintillation counter. At $E_\beta > 200$ kev, coincidences were observed with 368- and 579-kev $\gamma$ quanta. At $E_\beta > 600$ kev, coincidences are observed with 368-kev $\gamma$ quanta, and no coincidences were observed for $\beta^+$ particles having an energy $E_\beta > 1200$ kev. The results confirmed the decay scheme of $Tl^{200}$ presented by Herrlander and Gerholm in Nucl. Phys. 3: 161(1957). (TTT)

**7710** A STUDY OF THE $\gamma$-SPECTRUM OF $Au^{197*}$, AND OF THE $\beta^+$-SPECTRUM OF $O^{15}$. S. S. Vasil'ev and L. Ya. Shvtvalov (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1261-2(Oct. 1963). (In Russian)

The $\beta$ spectrum of a short-lived isotope with a half life of less than a few minutes can be investigated by introducing a beam of charged particles from a cyclotron into a magnetic-lens $\beta$ spectrometer having a target at one of its focal points. The $\gamma$ radiation can also be investigated from the conversion electron lines. The $Au^{197*}$ isomer was prepared by the inelastic scattering of 13.7-Mev deuterons on $Au^{197}$. The conversion electron spectrum showed three peaks at energies of 117, 197, and 265 kev with a small peak at 153 kev. The 131-kev $\gamma$ quantum corresponded to the 117-kev conversion electron (conversion at the L-shell), and the 278-kev $\gamma$ quantum corresponded to the 197- and 265-kev conversion electrons (conversions at the K- and L-shells). The half life of $Au^{197*}$ was found to be 9 ± 2 seconds. The $\beta^+$ spectrum of $O^{15}$ was obtained by irradiating $C^{12}$ with $\alpha$ particles. The Fermi plot of the $\beta^+$ spectrum is a straight line with an upper limit of 1700 ± 20 kev. The half life of $O^{15}$ was found to be 1.9 ± 0.2 minutes. (TTT)

**7711** NEW DATA ON $Ir^{186*}$. T. V. Malysheva, L. N. Nikityuk, and B. A. Khotin (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1263(Oct. 1963). (In Russian)

The electron conversion spectrum of an iridium fraction, isolated from the spallation products of gold, was investigated on a $\pi\sqrt{2}$, double-focusing, magnetic $\beta$ spectrometer. A "double" half life was observed according to the 630.3-kev K- and L-conversion lines. The short-lived constituent showed a half life of 1.7 hours, and the half life of the longer-lived activity was 17 hours. The results indicated the existence of an $Ir^{186}$ isomer with $T_{\frac{1}{2}} = 1.7 \pm 0.2$ hours. (TTT)

**7712** NEW NEUTRON-DEFICIENT ISOTOPES OF TUNGSTEN. T. V. Malysheva, L. N. Nikityuk, B. A. Khotin, and R. I. Kuznetsova (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1264-6 (Oct. 1963). (In Russian)

Neutron-deficient isotopes of tungsten were produced by the spallation of bismuth or gold with 600-Mev protons in a synchrocyclotron. The bismuth target and added tungsten carrier were dissolved in a minumum amount of $HNO_3$ in the presence of HF. Tungstic acid was precipitated by means of $HNO_3$, and was dissolved in $NH_4OH$. Iron hydroxide was precipitated with $NH_4OH$, and Bi and Mo were precipitated as sulfides. Nb was extracted by chloroform from an ammoniacal solution, and tungstic acid was precipitated from the aqueous phase. These operations were performed 2 to 3 times. The tantalum daughter was separated from the tungsten fraction by adding tantalum carrier, and precipitating tantalum hydroxide with $NH_4OH$. The hydroxide was dissolved in a mixture of $H_2SO_4$ and HF. The tantalum was extracted with cyclohexanone, and back-extracted with a solution of ammonium oxalate and boric acid. The $\gamma$ spectra of the tungsten fraction and of the tantalum daughter are given. An activity with a half life of 1.5 hours is tentatively assigned to $W^{175}$. Rhenium was separated from tungsten by extraction with methylethylketone in order to determine the conversion electron spectrum of the tungsten fraction. (TTT)

**7713** THE $\gamma$-SPECTRUM AND THE ELECTRON CONVERSION SPECTRUM OF $Nd^{139}$. G. M. Kolesov, T. V. Malysheva, and L. N. Nikityuk (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1267-9(Oct. 1963). (In Russian)

A target of samarium oxide was irradiated with 660-Mev protons. After separating away most of the samarium by electrolysis on a mercury cathode, the neodymium fraction was obtained chromatographically about 4 to 6 hours after the proton irradiation. The $\gamma$ spectrum of the neodymium fraction was determined on a 100-channel $\gamma$ spectrometer. Gamma transitions were observed at 70, 110, 135, 220, 300, 510, 700, 950, and ~1450 kev. The conversion electron spectrum was determined on a double-focusing, $\pi\sqrt{2}$, magnetic $\beta$ spectrometer. The multipolarity of the transition was obtained from the K/L ratio. A new activity with a half life of ~6 minutes was found in the praseodymium fraction. (TTT)

**7714** THE ANGULAR AND ENERGY DISTRIBUTIONS OF $Na^{24}$ NUCLEI ON IRRADIATING ALUMINUM WITH 660 Mev PROTONS. L. P. Moskaleva and A. K. Lavrukhina. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1270-2(Oct. 1963). (In Russian)

The percent of $Na^{24}$ nuclei emitted in the forward direction was found to be 1.2% for an Al target having a thickness of 24.2 mg/cm$^2$, 4.0% for a thickness of 2.0 mg/cm$^2$, and 130% for a thickness of 0.26 mg/cm$^2$. The number of $Na^{24}$ nuclei remaining in the target is taken as 100%. The ratio of $Na^{24}$ nuclei in the "forward" direction to the number in the "backwards" direction was found to be 5.6 ± 1.4. The $Na^{24}$ nuclei were absorbed in two consecutive Mylar films having thicknesses of 8.5 mg/cm$^2$ (1st film). $Na^{24}$ nuclei with E > 24 Mev showed an isotropic distribution at angles of 60 to 180°, and a sharp increase at angles of 0 to 60°. $Na^{24}$ nuclei with E > 24 Mev but < 110 Mev showed a high concentration at angles of 0 to 15°. $Na^{24}$ nuclei having energies of 100 to 130 Mev in the forward direction were detected with an Al target having a thickness of 24.2 mg/cm$^2$. These "long-range" $Na^{24}$ nuclei from aluminum cannot be explained by assuming a cascade-evaporation model. A process of fragmentation also makes a contribution. The number of long-range $Na^{24}$ nuclei is 10% of the total number of nuclei formed in the cascade-evaporation process. (TTT)

**7715** AN INTENSIFICATION OF E2- AND E3-TRANSITIONS IN p-SHELL NUCLEI AS A MANIFESTATION OF THE SEPARATE SPACIAL EXISTENCE OF α-GROUPS. Z. Mattkhiz, V. G. Neudachin, and Yu. F. Smirnov (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1273-6(Oct. 1963). (In Russian)

The difference in neutron binding energy in $Be^8$ and $Be^9$, $C^{12}$ and $C^{13}$, etc., or the excitation energy of lower levels with T = 1 in $Be^8$, $C^{12}$ etc. indicate the separate existence of α groups in these light nuclei. The quadrupole moment (or quadrupole transition) can serve as a good measure of the separate existence of α groups in such nuclei as $Be^8$–$Be^9$, or $C^{12}$–$C^{13}$. Analysis of the electric transitions can be carried out by a cluster model. The shell model and the α model are two limiting variants of the cluster model. Quadrupole moments in p-shell are intensified by a factor of two or three compared to the usual values from the shell model, and rotational quadrupole transitions are intensified by a factor of four or more. It is argued that a cluster model explains these transitions in greater detail than the collective model does. Detailed calculations of the matrix elements are carried out for the simplest case involving the $Be^8$–$Be^9$ pair. Ratios of the matrix elements from the cluster model are compared to values from shell theory. Calculated values of Q and $\sqrt{\overline{r^2}}$ are also presented. Interpolations are made between the shell-model values and the α model values in order to simplify the calculations. (TTT)

**7716** THE EFFECT OF THE FINITE DIMENSIONS OF THE NUCLEUS ON THE POLARIZATION OF PARTICLES DURING PAIR FORMATION AND BREMSSTRAHLUNG RADIATION. F. S. Sadykhov (Inst. of Physics, Azerbaidzhan Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1277-80(Oct. 1963). (In Russian)

With the use of a Born approximation for high-energy γ quanta, the angular distribution of longitudinally polarized electron-positron pairs is described with allowance being made for the finite dimensions of the nucleus. The results are presented in the form of a plot of a cross-section ratio for an elongated nucleus and a point nucleus as a function of the square of the radius for an incident γ quanta with $E_\gamma$ = 50 Mev and formation of a positron with $E_+$ = 35 Mev at angles of positron emission $\theta_+$ = 60 and 90°. The degree of polarization decreases with increasing dimensions of the nucleus. The angular distribution of circularly polarized bremsstrahlung radiation from a longitudinally polarized electron is plotted for an incident electron with $E_e$ = 50 Mev and emission of a γ quanta with $E_\gamma$ = 25 Mev at $\theta$ = 60°. The degree of circularly polarized bremsstrahlung radiation falls off significantly with increasing value of the square of the radius of the nucleus. (TTT)

**7717** AN INVESTIGATION OF THE DECAY SCHEME OF $Re^{184}$ BY $e^-e^-$-COINCIDENCE COUNTING. B. S. Dzhelepov, P. A. Tishkin, and I. A. Shishelov. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1281-4(Oct. 1963). (In Russian)

A sample of $Re^{184}$ was obtained by irradiating tungsten with deuterons on a cyclotron. The $Re^{184}$ activity ($T_{1/2}$ = 34 days) contained an equal amount of $Re^{183}$ activity as an impurity. The relative content of $Re^{184}$ decreased with time. The conversion electron coincidences from the decay of $Re^{184}$ to $W^{184}$ were investigated on a double toroidal β spectrometer having a resolution of 1.8% for the K 793.4 line. Coincidences of L 111.2 electrons were found with K 253, L 253, K 383, K 540, K 642, K 793, L 793, K 896, and L 896 electrons, and also with conversion electrons having an energy of 945 ± 10 kev. The K 983 electrons coincide with K 253 and L 253 electrons, but do not coincide with K 793 electrons. A $6^+$ level having an energy of 747 kev can be introduced into the rotational band with K = 0 on the basis of these data. The ratio of conversion coefficients K/(L + M) was found to be: K 253/(L + M)253 = 1.6 ± 0.3, and K 383/(L + M)383 = 3 ± 1. The theoretical values for an E2-transition are 1.7 and 2.7, respectively. A part of the $Re^{184}$ decay scheme involving two rotational bands with K = 0 and K = 2 is given. (TTT)

**7718** A STUDY OF THE COULOMB EXCITATION OF THE FIRST LEVELS OF SPHERICAL EVEN-EVEN NUCLEI BY MEASURING THE COINCIDENCES OF γ-QUANTA AND OF INELASTICALLY SCATTERED IONS. D. G. Alkhazov, D. S. Andreev, V. D. Vasil'ev, Yu. P. Gangrskii, I. Kh. Lemberg, and Yu. I. Udralov. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1285-96(Oct. 1963). (In Russian)

Enriched targets of $Sr^{84}$, $Sr^{86}$, $Sr^{88}$, $Zr^{92}$, $Zr^{94}$, $Ba^{134}$, $Ba^{136}$, and $Sm^{144}$ were bombarded with 44- or 52-Mev nitrogen ions. The γ quanta from the first excited levels of these nuclei were counted in coincidence with the inelastically scattered, heavy, nitrogen ions. Four p-n detectors were used to count the nitrogen ions, scattered at an angle of 135° with respect to the incident beam. A NaI(Tl) scintillation detector was used to count the γ quanta. The high level of background γ radiation due to the reaction of heavy nitrogen ions with impurities such as oxygen and carbon was eliminated by coincidence counting. A $2^+$ level with an energy of 800 ± 15 kev was identified in $Sr^{84}$. The first energy levels in $Zr^{92}$ and $Zr^{94}$ were each found to be equal to 920 kev. The first $2^+$ level in $Sm^{144}$ was found to have an energy of 1630 kev, and a lifetime of $0.9 \times 10^{-13}$ seconds. The energies, life times, and B(E2)↑ probabilities are tabulated for all the spherical even-even nuclei which were investigated. (TTT)

**7719** THE MECHANISM OF α-DECAY, AND THE REDUCED LEVEL WIDTHS OF $Po^{210}$ AND $Po^{212}$. K. B. Baktybaev and B. M. Bukat. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1297-1304(Oct. 1963). (In Russian)

The simple model of the penetration of a potential barrier by an α particle can be modified by introducing the reduced width $\gamma_L$, whose square characterizes the probability for formation of an α group within the nucleus: $\gamma_L = (2\gamma_L^2/\hbar)P_L$. Here λ is the decay constant for the emission of an α parti-

cle with a definite orbital moment L, and $P_L$ is the barrier penetrability. The value of $\gamma_L$ is determined by the behavior of the internal wave function of the nucleus, and the probability of $\alpha$ decay can be related to the nuclear structure. The reduced widths for $\alpha$ decay are calculated for $Po^{210}$ and $Po^{212}$ by taking into account the role of correlations associated with residual pair interactions in the nucleus. A number of $\alpha$ transitions to excited states are strongly forbidden due to the low probability of $\alpha$ particle formation in the nucleus. Values of $\gamma^2_{pure}$, calculated on the assumption that the nuclear states are pure shell states, are compared with values of $\gamma^2_{mixed}$, where the residual pair interactions lead to mixed configurations. It is shown that the probability of $\alpha$ decay in $Po^{210}$ and $Po^{212}$ is strongly dependent on tunneling effects. (TTT)

**7720** THE ELASTIC SCATTERING OF PROTONS BY $Be^9$ AND $B^{11}$ NUCLEI. G. B. Andreev, A. S. Deineko, and I. Ya. Malakhov (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1305-7(Oct. 1963). (In Russian)

A $Be^9$ target was prepared by evaporating metallic beryllium onto a thin organic backing. The boron target was prepared in a magnetic mass separator by hitting a thick beryllium backing with $B^{11}$ ions. The density of the targets was on the order of 20 $\mu g \cdot cm^{-2}$. The relative differential cross section of elastic scattering was measured for incident proton energies of 1.67 to 4.09 Mev at an angle of 140.8°. A magnetic spectrometer separated out the elastically scattered protons, which were counted on a scintillation counter. A discriminator was used to eliminate $\alpha$ particles. In the $Be^9(p,p)Be^9$ reaction, only one resonance was detected at an energy of 2.57 Mev with a width of about 100 kev, which corresponds to the 8.89 Mev level of the $B^{10}$ nucleus. In the $B^{11}(p,p)B^{11}$ reaction, four resonances were detected at proton energies of 2 (80 kev width), 2.63 (a width of ~300 kev), 3.15 (~90 kev width), and a little above 4 Mev (width > 400 kev). The corresponding level energies of the $C^{12}$ nucleus are 17.77, 18.37, 18.85, and > 19.62 Mev. These resonances were all observed in other reactions. The contribution from undetected resonances can be estimated only on carrying out a phase analysis of the data after determining the absolute cross section for elastic scattering on these nuclei. (TTT)

**7721** THE QUADRUPOLE EXCITATION OF ATOMIC NUCLEI. V. G. Shevchenko, N. P. Yudin, and B. A. Yur'ev. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1313-18(Oct. 1963). (In Russian)

A study of the $(\gamma,p)$ reaction on heavy nuclei shows a quadrupole absorption maximum at $\gamma$ quanta above 20 Mev. Two types of excited states should be observed; one at a few Mev, and the other due to the quadrupole polarized oscillations of protons with respect to neutrons. The magic nuclei $O^{16}$, $Ca^{40}$, $Pb^{208}$, and the "almost magic" nucleus $Zr^{90}$ were investigated with regard to these excited states by using a shell model and taking account of residual pair interaction in the nucleus. The inclusion of the residual pair interaction leads to the formation of two states $\psi_1$ and $\psi_2$, which are different in energies and properties. The energy difference between these two states can be ~18 Mev in $Pb^{208}$ for dipole transitions. The energies of these levels, or relatively narrow groups of levels, are as follows: $E_1 = E_0 - 4.46$ b and $E_2 = E_0 + 2.3$ b for $Pb^{208}$; $E_1 = E_0 - 3.8$ b and $E_2 = E_0 + 1.8$ b for $Zr^{90}$; $E_1 = E_0 - 2.9$ b and $E_2 = E_0 + 1.7$ b for $Ca^{40}$, and $E_1 = E_0 - 2.2$ b and $E_2 = E_0 + 1.3$ b for $O^{16}$. Here $b = |g|/(4\pi^2 r_0^3)$, where $r_0$ is a parameter of the oscillator function. $E_0$ is the energy of the $\psi_1$ and $\psi_2$ states for the zeroth approximation. If b is taken equal to ~3.14, the change in energies $\Delta V_1$ and $\Delta V_2$ of the $\psi_1$ and $\psi_2$ states due to residual interaction increases with atomic weight A, and is ~21 Mev for $Pb^{208}$. The positions of levels of the zeroth approximation are estimated in $Pb^{208}$, $Zr^{90}$, $Ca^{40}$, and $O^{16}$. (TTT)

**7722** THE CONCEPT OF THE DENSITY AND POTENTIAL OF A NUCLEUS AS REPRESENTED BY VARIOUS ANALYTICAL FUNCTIONS, AND THE USE OF THESE FUNCTIONS IN STUDYING THE INTERACTION OF A PARTICLE WITH A NUCLEUS. M. Z. Maksimov (Inst. of Physics and Tech., Academy of Sciences, Georgian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1319-28(Oct. 1963). (In Russian)

The density of a nucleus n(r), and its potential V(r) must be known as a function of distance in most studies dealing with the passage of a particle through a nucleus. The Woods-Saxon distribution is most frequently used to improve the agreement between theory and experiment: $V_1(\lambda,\rho-1) = [1 + \exp\lambda(\rho-1)]^{-1}$, where $\rho = r/R_0$. The parameter $\lambda$ in $U_1$ characterizes the rate of fall of $U(\lambda,\rho-1)$ near $r = R_0(\rho = 1)$, and can be related to the diffuseness of the sides of the potential well $\Delta$. The function $U_1$ is a unitary function which can be represented in other forms such as the following: $U_3 = \frac{1}{2}[1-(2/\pi)\text{arctg}\,\lambda\chi]$; $U_4 = (1/\pi)\int_{\lambda\chi}^{\infty}(\sin\tau/\tau)d\tau$; $U_5 = (\frac{1}{2}[1-\int_0^{\lambda\chi}\exp-|\tau|d\tau$; and $U_6 = (\frac{1}{2}[1-\phi(\lambda\chi)]$. These formulas do not exhaust all the possibilities. These formulas can be expressed in terms of Fourier components which can be used in handling various experimental data on the scattering of charged particles. The superiority of the $U_5$ function in solving the Schroedinger equation for the s-state is demonstrated. The cross sections for elastic and inelastic scattering can be calculated. The effect of the diffuseness of the potential barrier on the cross section for the interaction of a slow particle with a nucleus can be followed in detail with the use of the $U_5$ form. The scattering of a fast charged particle is also discussed in detail. (TTT)

**7723** SUPERFLUIDITY AND THE EXCITED STATES OF SPHERICAL NUCLEI HAVING AN ODD ATOMIC NUMBER. B. L. Birbrair. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1329-37(Oct. 1963). (In Russian)

Pair correlation is ordinarily applied to an atomic nucleus by using a boson approximation. Field theory is applied to a system of interacting quasiparticles in order to explain the break-down of a phonon into two quasiparticles, and other virtual processes such as the emission or absorption of a phonon by a quasiparticle. A model hamiltonian of the nucleus was considered with pairing and quadrupole-quadrupole interaction. It was found that single-particle states exist in nuclei with odd A, and the quadrupole-quadrupole interaction has practically no effect on the energy of these states. The ground state of a nucleus with odd A is always a state of this type. The method of establishing the type of excited state in a nucleus with odd A is to compare the theoretical and experimental values of the reduced probability of an E2-transition between the state in question and any other state known to be a single-particle state (for example, a ground state). This transition is a pure collective transition so that the value of B(E2) can exceed the single-particle value by a considerable amount. It is thus possible to calculate the energies and B(E2) values of the first $2^+$ levels in nuclei with odd A. (TTT)

**7724** THE ISOTOPIC MASS AND BINDING ENERGIES OF NUCLEONS IN THE RARE EARTH REGION ($150 < A < 176$, $63 < Z < 71$). R. A. Demirkhanov, V. V. Dorokhov,

and M. I. Dzkuya. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1338-56(Oct. 1963). (In Russian)

A total of 108 doublets was measured on a double-focusing mass spectrograph having a resolution of 50,000 to 70,000. The masses of 34 stable isotopes from europium to lutetium were calculated from the data with reference to $C^{12} = 12{,}000{,}000$. The mass of each isotope was calculated from a number of independent doublet measurements with different organic fragments. Because of the high resolution of the mass spectrometer, it was possible to resolve organic impurities containing the $C^{13}$ isotope. The average relative error was 2 to $5 \times 10^{-7}$ after taking into account the "internal" agreement of the results. The masses $H^1$, $C^{13}$, $N^{14}$, $O^{16}$, $Cl^{35}$, $Cl^{37}$, and those of mercury isotopes were used as reference standards. The results are in good agreement with those reported by Bhanot, Johnson, and Nier in Phys. Rev., 120: 235(1960), but in a number of cases, the superior resolution with respect to the $C^{13}$ isotope gave improved results. The masses and binding energies of 54 radioactive isotopes were calculated from the data of this work. In addition, the binding energy of the last neutron, the binding energy of the last proton, the binding energy of the last two neutrons, and the pairing energy of neutrons and protons are presented for the various rare earth isotopes. (TTT)

**7725** AN ISOMERIC STATE OF $Nd^{139}$. K. Ya. Gromov, A. S. Danagulyan, A. T. Strigachev, and V. S. Shpinel'. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1357-9(Oct. 1963). (In Russian)

A tantalum target was irradiated with 600-Mev protons on a cyclotron, and a Nd fraction was isolated 4 to 5 hours after the irradiation. The conversion electron spectrum was taken over an energy region of 15 to 900 kev on a magnetic spectrograph having a resolution of 0.08%. All the conversion electron lines were ascribed to the decay of $Nd^{139}(T_{\frac{1}{2}} = 5.5$ hrs). On comparing the experimental values with the theoretical values for the difference in energy of the conversion electrons for the 232.5-kev transition, it was established that all the transitions except the 232.5-kev transition occur in the Pr nucleus. It was found that the 232.5-kev transition is of the M4 type. Thus, the existence of an isomeric state of $Nd^{139*}$ with an energy of 232.5 kev can be considered as established. Similar isomeric states exist in the four neighboring isotopes of $Te^{131*}$, $Xe^{133*}$, $Ba^{135*}$, and $Ce^{137*}$. From data on the relative intensities of the conversion electrons from the 232.5- and 113.8-kev $\gamma$ transitions, it is estimated that only 18% or less of the transitions take place through the isomeric state of $Nd^{139*}$ to the ground state, and most of the disintegrations take place by $\beta$ conversion to excited levels in $Pr^{139}$. (TTT)

**7726** ANOMALOUS ELECTRIC DIPOLE TRANSITION IN $Ta^{179}$. J. Valentin and A. Santoni (Institut du Radium, Orsay, France). J. Phys., 24: 648-52(Sept. 1963). (In French)

A 30.7-kev anomalous electric dipole transition has been found in $Ta^{179}$ by means of high resolution 180° spectrographs and with scintillation techniques. Using a source made of a mixture of $W^{179}$ and $W^{176}$ (which is known to have a 100 kev E1 transition) we have found that $\alpha_{L_{III}}$ for an anomalous E1 has the same value as a normal E1 transition. This fact allows us to give the internal conversion coefficients with an accuracy of about 20%. (auth)

**7727** QUADRUPOLE RELAXATION OF THE ISOTOPE $Hg^{201}$ ON A QUARTZ SURFACE. C. Cohen-Tannoudji (Laboratoire de Physique de l'E. N. S., Paris). J. Phys., 24: 653-60(Sept. 1963). (In French)

Nuclear relaxation produced by collisions on quartz walls of optically oriented $Hg^{201}$ atoms is studied theoretically and experimentally. The relaxation mechanism is assumed to be the quadrupole coupling between the $Hg^{201}$ nucleus and the electrical field gradients, which appear at the nucleus during the adsorption of the atom on the wall. The general formalism of the theory of relaxation in liquids and gases is used to obtain the time evolution of the density matrix representing the ensemble of atoms. The various longitudinal and transverse relaxation times are expressed as a function of the microscopic physical quantities, which describe the adsorption of the atom on the wall. The various relaxation times have been measured by carrying out the magnetic resonance on an optically pumped $Hg^{201}$ vapor and by observing on the optical signals the transient phenomena, which appear when the r-f field is shut off. In particular, the free precession of the $Hg^{201}$ nuclei has been detected on the modulation at the Larmor frequency of the optical absorption of the vapor. All the experimental results are in agreement with the predictions of the above theoretical model, particularly for the ratios between the various relaxation times. In this way, one can obtain informations on some of the microscopic physical quantities, such as correlation time and dwell time. (auth)

**7728** PROOF OF ALPHA STRUCTURES IN HEAVY NUCLEI. H. Gauvin, M. Lefort, and X. Tarrago (Faculté des Sciences, Orsay, France). J. Phys., 24: 665-71 (Sept. 1963). (In French)

Calculations are carried out with electronic computers, in order to explain the emission of alpha particles in high energy proton reactions on Bi by a "knock-out" mechanism. It is assumed that cascade nucleons are elastically scattered by $\alpha$ structures before they escape from a bombarded nucleus. The computation fits experimental data on emitted $\alpha$ particles spectra if it is assumed that 15 $\alpha$ clusters exist on the nuclear surface and they have a mean kinetic energy of 10 Mev inside the nucleus. Such a result indicates that about 70% of surface nucleons are arranged in helion clusters. (auth)

**7729** TECHNIQUES FOR THE STUDY OF RADIATIVE ALPHA-CAPTURE REACTIONS. J. A. Weinman (Argonne National Lab., Ill.). Nucl. Instr. Methods, 24: 390-4(Oct. 1963). (TID-18596)

Apparatus for the study of radiative alpha-capture reactions was designed to achieve maximum beam on the target and minimum background from the $C^{13}(\alpha,n)O^{16}$ reaction. To meet these goals, the energy of the electrostatic accelerator was controlled by a 25° magnetic momentum analyzer that transmitted large beam currents. The beam energy was calibrated by means of an electrostatic energy analyzer. A wobble target assembly was constructed without the use of organic components so that it could be baked to eliminate residual organic contaminants. (auth)

**7730** INTERACTION OF 26 Mev DEUTERONS WITH $C^{12}$. R. Van Dantzig and L. A. Ch. Koerts (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys., 48: 177-90(Oct. 1963).

Targets containing natural carbon were bombarded with 26-Mev deuterons. The outgoing protons and deuterons were detected and identified with an E-dE/dx type particle identification system. Absolute differential cross sections were measured simultaneously for elastic scattering on $C^{12}$, inelastic scattering corresponding to the levels in $C^{12}$ at 4.43 ($2^+$), 7.65 ($0^+$), and 9.63 Mev ($2^+$), and for the $C^{12}(d,p)$ reaction to the ground state and to the first ex-

cited state at 3.09 Mev in $C^{13}$. The angular distribution for elastic scattering was analyzed in terms of simple diffraction models. A comparison was made with the theoretical curves according to the sharp cutoff model with and without Coulomb phase-shifts and with the Fraunhofer prediction. The cross section curves corresponding to the excitation of the 4.43 and 7.65-Mev levels were compared with theoretical curves according to the inelastic diffraction model. Although fair agreement between theory and experiment could be established for the elastic scattering, this was impossible for the inelastic case. However, the yields of the inelastic scattering from the 4.43 and 7.65-Mev levels agree with a collective nature of the transitions to the corresponding nuclear states. The angular distributions of the proton groups of the $C^{12}(d,p)C^{13}$ reaction were analyzed in terms of the Butler-Born-approximation model. (auth)

**7731** CROSS SECTION MEASUREMENTS OF THE $^{58}Ni(n,p)^{58}Co$ AND $^{29}Si(n,\alpha)^{26}Mg$ REACTIONS IN THE ENERGY RANGE 2.2 TO 3.8 Mev. J. Konijn and A. Lauber (Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Phys., 48: 191-208(Oct. 1963).

The $Si^{29}(n,\alpha)Mg^{26}$ and $Ni^{58}(n,p)Co^{58}$ reaction cross sections were measured using a surface barrier solid state detector to record the charged particles. Absolute measurements of the neutron flux were made, recording the proton recoils from a thin polyethylene radiator with the solid state detector. Both reaction cross sections show strong fluctuations as a function of energy, which may be due to the statistical fluctuation of the level densities. Estimations of the level densities of the intermediate nuclei from the relative fluctuations of the cross section curves are in good agreement with those expected on theoretical grounds. The agreement with earlier measurements on the nickel reaction is good, while absolute values for the cross sections of the silicon reaction were not reported before in this energy region. (auth)

**7732** MEASUREMENT OF THE FLUORESCENT YIELDS OF THE L-SHELL. K. Hohmuth, G. Mueller, and J. Schintlmeister (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Nucl. Phys., 48: 209-24(Oct. 1963). (In German)

The average fluorescent yields of the L-shell $\overline{\omega}_L$ of rubidium, niobium, silver, tellurium, lanthanum, holmium, and mercury were determined. The L-subshells were excited through electron capture and internal conversion. Measurements were made by coincidence methods using proportional counters and scintillation counters. The results of the measurements are compared with those of others and also with the curves given by Listengarten for the partial fluorescent yields of the L-shell and for the coefficients of the Coster-Kronig-transitions. The fluorescent yield $\omega_{K1}$ is calculated using approximate formulas for $\omega_2$ and $\omega_3$ and then compared with the experimental values. The agreement between calculated and observed values is found to be satisfactory. (auth)

**7733** SEARCH FOR THE ISOMERIC DECAY OF 4.9 h $In^{110m}$ TO $In^{110}$. J. H. Hamilton (Instituut voor Kernphysisch Onderzoek, Amsterdam and Vanderbilt Univ., Nashville) and A. R. Sattler. Nucl. Phys., 48: 225-9(Oct. 1963).

A search was made for the proposed isomeric and fast transitions from the decay of 4.9 h $In^{110m}$ with spin 7 to $In^{110}$ with spin 2 via an intermediate state of spin 3 or 4. The energies of these two predicted transitions must be less than 33 kev. The electron spectrum was measured from 5-40 kev in an iron-free, double-focusing spectrometer. Only the cadmium Auger lines were observed. From a comparison of the measured Auger spectrum of cadmium, an upper limit of 0.03% was made for the missing isomeric transition. The positron spectra from the decay of the $In^{110m}$-$In^{110}$ sample was measured periodically over a period of 17 h. The half-life of $In^{110}$ was measured to be 69 ± 2 min. From the possible admixture of the 4.9 h component in the 69 min $In^{110}$ 2.2-Mev beta group, an upper limit of 0.008% was made for the isomeric decay. These data exclude an intermediate level between $In^{110m}$ and $In^{110}$ of spin 4 but do not exclude a very weak E4 or M4 isomeric transition to an intermediate level of spin 3. (auth)

**7734** DECAY OF $Bi^{205}$. S. H. Vegors, Jr., R. L. Heath, and D. G. Proctor (Phillips Petroleum Co., Idaho Falls, Idaho). Nucl. Phys., 48: 230-62(Oct. 1963).

The decay of $Bi^{205}$ was studied using scintillation spectrometers for gamma ray and gamma-gamma coincidence studies, and 180° permanent magnet photographic spectrometers for internal conversion spectra. Eighty-three gamma rays were identified, of which forty are previously unreported. Relative intensities of many of the prominent gamma rays were obtained by an analysis of the gamma ray spectrum. A partial decay scheme for $Pb^{205}$ is presented. (auth)

**7735** THE K-CONVERSION COEFFICIENT OF THE 279 kev TRANSITION IN $Tl^{203}$ BY A COINCIDENCE TECHNIQUE AND ESTABLISHMENT AS A STANDARD. W. L. Croft, B. -G. Pettersson, and J. H. Hamilton (Vanderbilt Univ., Nashville). Nucl. Phys., 48: 267-72(Oct. 1963).

The K-conversion coefficient of the 279-kev transition in $Tl^{203}$ was measured by a coincidence technique. The K-conversion electrons and beta rays following the decay of $Hg^{203}$ were detected in a magnetic lens spectrometer in coincidence with x rays and gamma rays, respectively. From these data, the probability of K-conversion electron emission $\kappa_{eK}$ was determined to be 0.132 ± 0.002. The K-conversion coefficient was calculated from $\epsilon_K = \kappa_{eK}/[1 - \kappa_{eK}(K + L + M + N)/K]$ to be 0.162 ± 0.003. The consistent $\epsilon_K$ results from several different techniques suggest this is a useful standard for conversion coefficient measurements in this energy range. (auth)

**7736** FIRST FORBIDDEN $1^-(\beta^-)0^+$ AND $1^-(\beta^-)2^+(\gamma)0^+$ TRANSITIONS OF THE ISOTOPES $Re^{186}$ AND $Re^{188}$. D. Bogdan (Inst. for Atomic Physics, Bucharest). Nucl. Phys., 48: 273-91(Oct. 1963).

The spectral shapes, directional $\beta-\gamma$ correlation, $\beta-\gamma$ correlation with circular polarization, longitudinal polarization of the electrons and ft values were computed. The ft values were evaluated taking into account the correction given by the superfluid model of the nucleus. A satisfactory agreement was obtained between theory (Nilsson and superfluid model) and experiment, especially in the case of $Re^{186}$. It was found that between the matrix elements $f_\alpha$ and $f_\tau$ there is a relation in agreement with that predicted by Ahrens and Feenberg and in disagreement with that given by the theory of conservation of the vector current. (auth)

**7737** EXPERIMENTAL DETERMINATION OF THE TOTAL CONVERSION COEFFICIENT OF THE 0.265 Mev TRANSITION IN $Mo^{93m}$. H. E. Bosch, F. Krmpotic, and A. Plastino (Universidad Nacional, La Plata). Nucl. Phys., 48: 292-8(Oct. 1963).

A new procedure for measuring internal conversion coefficients is pointed out, based on the replacement of a

magnetic spectrometer by a solid state detector. The particular measurement of the total conversion coefficient for the 0.265-Mev transition in $Mo^{93m}$ is described. The results in agreement with the theoretical value calculated by Rose. The accuracy of the method is stated to be comparable to that obtained by means of electron-gamma coincidences with magnetic spectrometers. The result quoted for the total conversion coefficient of the 0.265-Mev transition in $Mo^{93m}$ is $\alpha_T = 0.72 \pm 0.05$= (auth)

**7738** INVESTIGATION OF THE REACTION $Li^6(d,\alpha)He^4$ AT DEUTERON ENERGY 1-2.5 Mev. Y. P. Antoufiev, M. M. El-Shesheni, H. R. Saad, Z. A. Saleh, and P. V. Sorokin (Atomic Energy Establishment, Cairo). Nucl. Phys., 48: 299-304(Oct. 1963).

The relative yield of the reaction $d + Li^6 \rightarrow 2\ He^4 + 22.3$ Mev in the deuteron energy interval of 1-2.5 Mev and the angular distributions of $\alpha$ particles at $E_d = 1$, 1.25, 1.5, 1.75, 2.00, 2.25, and 2.50 Mev were measured with the aid of semiconductor detectors. The experimental angular distributions agree well with the calculated ones in the assumption of pick-up interaction for the reaction $Li^6(d,\alpha)He^4$. (auth)

**7739** ISOMERIC TRANSITIONS IN $^{122m}Sb$. L. Ciuffolotti (SORIN, Saluggia, Italy) and F. Demichelis. Nucl. Phys., 48: 305-12(Oct. 1963).

The isomer $Sb^{122m}$ was experimentally investigated. The half-life is found to be 4.15 ± 0.15 min: the $\alpha_K$ conversion coefficients for the transitions of 60 and 75 kev were found to be 0.65 ± 0.03 and 2.88 ± 0.16, respectively. Multipolarity assignments were made, and the spins and parities of the levels were definitely established. The $Sb^{122m}$ levels are discussed in terms of both the shell model and the unified model. (auth)

**7740** THE LEVEL SCHEME OF $Sb^{119}$. J. Svedberg and G. Andersson (Uppsala Univ.). Nucl. Phys., 48: 313-20(Oct. 1963).

Conversion electrons and electron-gamma coincidences in the decay of $Te^{119m}$ were studied in order to establish energy levels of $Sb^{119}$. The results agree with level positions proposed by others on the basis of gamma scintillation spectroscopy. An intensity discrepancy is pointed out, which makes earlier spin-parity assignments questionable. It is shown that the difficulty can be released, if a high-spin level at 1.37 Mev is assigned negative parity, making the multipolarities of its three depopulating transitions E1, M2, and E3, respectively. (auth)

**7741** ELECTRON SCATTERING ON LIGHT NUCLEI. Raj K. Gupta and Y. R. Waghmare (Panjab Univ., Chandigarh, India). Nucl. Phys., 48: 321-4(Oct. 1963).

Calculations of the nuclear scattering of high energy electrons are made, with a Saxon-Woods distribution of charge, for light nuclei having large quadrupole moments. It is shown that the contribution due to quadrupole scattering forms a sizable part of the total elastic scattering cross section. A variation of the deformation parameter is found in conformity to expectation. (auth)

**7742** SINGULARITY WITH RESPECT TO THE MOMENTUM TRANSFER OF A CERTAIN TYPE OF GRAPHS FOR LOW-ENERGY NUCLEAR REACTIONS. E. Truhlík (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Řež). Nucl. Phys., 48: 329-32(Oct. 1963).

A formula is obtained for a type of singularities with respect to the momentum transfer in two-loop graphs. Numerical calculations are given for the singularities of some stripping reactions. (auth)

**7743** BORN APPROXIMATION IN THE INTERNAL PAIR FORMATION. R. -J. Lombard and A. Boers (Federal Inst. of Tech., Zurich). Nucl. Phys., 48: 333-6(Oct. 1963).

Following the method of Gorshkov and Krutov the Born series was calculated to the second order and applied to the differential coefficient of internal pair formation. The results are compared to the exact calculation for several values of Z and the transition energy. (auth)

**7744** ON THE E1-M1 INTERFERENCE TERM IN LOW-ENERGY PHOTODISINTEGRATION. G. Ponzano (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cimento (10), 30: 77-81(Oct. 1, 1963).

The photodisintegration of polarized single-particle nuclei is considered in the case of circularly polarized photons, and the angular correlation formulas due to the E1-M1 interference are evaluated. Then, the particular case of $C^{13}$ is treated. Numerical calculations show that the E1-M1 interference affects the angular correlations even at low energies, leading to a forward asymmetry in the neutron differential cross-section and to a small distortion of the transversal polarization. (auth)

**7745** ON A NEW APPROACH TO ALPHA-DECAY AND ITS APPLICATION TO THE ANGULAR CORRELATION OF THE DECAY $^{233}U \xrightarrow{\alpha} {}^{229}Th \xrightarrow{\gamma} {}^{229}Th$. E. Salusti (Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (10), 30: 171-6(Oct. 1, 1963).

A new method is proposed to find the initial conditions necessary to solve the differential equations that describe $\alpha$ decay from deformed nuclei. This method is based on a variational formulation of the problem and is used to calculate the $\alpha$-$\gamma$ angular correlation in the $U^{233} \xrightarrow{\alpha} Th^{229} \xrightarrow{\gamma} Th^{229}$ decay. The results fit the experimental results better than calculations that used methods previously existing. A comparison of this method with others is included. (auth)

**7746** SMALL EFFECTS IN $\beta$-DECAY STUDIES OF THE CONSERVED VECTOR CURRENT. R. M. Spector and M. S. Spergel (Univ. of Rochester, N. Y.). Nuovo Cimento (10), 30: 205-6(Oct. 1, 1963).

The inclusion of certain small higher-order effects in the analysis of $\beta$ decay is shown to have negligible effects on the conclusions drawn about the conserved vector current theory of weak interactions. The same is true of the value of the weak coupling constant as determined from nuclear $\beta$ decay. (auth)

**7747** IDENTITY EFFECTS IN MULTIPLE-SCATTERING THEORIES. K. L. Kowalski (Case Inst. of Tech., Cleveland). Nuovo Cimento (10), 30: 266-77(Oct. 1, 1963).

The investigation of Takeda and Watson concerning the effects of the Pauli principle on the scattering of high-energy nucleons by nuclei is reconsidered and extended. Multiple-scattering and optical-model formalisms are found that include all identity effects in such a way so as to permit a systematic evaluation of the so-called target-exchange corrections. Although no assumptions are made concerning the number of target nucleons, the formalism is expected to be useful primarily for light nuclei. (auth)

**7748** ON THE SUPERFLUID STATE OF STRONGLY-INTERACTING FERMIONS. P. Szépfalusy (Roland Eötvös Univ., Budapest). Nuovo Cimento (10), 30: 462-5(Oct. 1, 1963).

A model two-particle interaction hamiltonian is proposed to overcome the difficulties arising from the pres-

ence of strong short-range potentials (hard cores) in N–N and $He^3$–$He^3$ interactions in the superfluid description of nuclear matter and liquid $He^3$. (C.E.S.)

**7749** INTERNAL CONVERSION COEFFICIENT MEASUREMENTS IN $^{141}Pr$ AND $^{54}Cr$. G. N. Rao (Muslim Univ., Aligarh, India). Nuovo Cimento (10), 30: 507-11(Oct. 16, 1963).

The K internal conversion coefficient of the 145-kev transition in the decay of $Ce^{141}$ and the total internal conversion coefficient of the 840-kev transition in the decay of $Mn^{54}$ are measured with scintillation spectrometers to be $(0.38 \pm 0.04)$ and $(2.0 \pm 0.5) \times 10^{-4}$, respectively. These values are compared with the theoretical calculations. (auth)

**7750** NUMERICAL METHODS FOR D.W.B.A. CALCULATIONS ON (n,p) REACTIONS. A. Agodi (Università, Catania, Italy), R. Giordano, G. Schiffrer, and M. Giannini. Nuovo Cimento (10), 30: 644-55(Oct. 16, 1963).

The methods employed for the numerical evaluation of angular distributions of protons from (n,p) reactions, in the framework of the distorted-wave Born approximation (D.W.B.A.), are presented and discussed. The calculations were performed for two particular forms of the n-p interaction, i.e., a zero-range potential and a Yukawa potential including Majorana exchange. (auth)

**7751** INELASTIC SCATTERING OF α PARTICLES BY $Ni^{62}$, $Cu^{63}$, $Ni^{64}$, $Cu^{65}$ AND CORE-PARTICLE INTERACTION. G. Bruge, J. C. Faivre, M. Barloutaud, H. Faraggi, and J. Saudinos (Centre d'Etudes Nucleaires, Saclay, France). Phys. Letters, 7: 203-6(Nov. 15, 1963). (In French)

The plausibility of interpreting the inelastic scattering of alpha particles by the odd nuclei $Cu^{63}$ and $Cu^{65}$ in terms of the coupling of a $^3/_2^-$ proton to the nuclei $Ni^{62}$ and $Ni^{64}$, respectively is examined. It is assumed that there is a non-negligible interaction between the outside proton and the even Ni nucleus. The interpretation is based on a comparison of inelastic alpha scattering by the four nuclei under consideration. (T.F.H.)

**7752** DISTRIBUTION OF LEVEL SPACINGS OF $U^{236}$, EXCITED IN $U^{235}$ BY SLOW NEUTRONS AND DETECTED BY TRANSMISSION OF METALLIC SAMPLES OF $U^{235}$ MAINTAINED AT LOW TEMPERATURE. A. Michaudon, H. Derrien, P. Ribon, and M. Sanche (Centre d'Etudes Nucleaires, Saclay, France). Phys. Letters, 7: 211-14 (Nov. 15, 1963). (In French)

A disagreement is shown between the observed $U^{235}$ resonance spacings and the predictions of the Wigner law for two populations. Causes and remedies for this disagreement are suggested. Only the $3^-$ and $4^-$ levels in $U^{236}$ are excited, if the excitation is assumed to be produced only by s-wave neutrons. (T.F.H.)

**7753** QUADRUPOLE MOMENT OF $Li^6$. Lennard Wharton, L. Peter Gold, and William Klemperer (Harvard Univ., Cambridge, Mass.). Phys. Rev., 133: B270-2 (Jan. 27, 1964).

Analysis of a relatively well-resolved molecular beam electric resonance spectrum of $Li^6F$ $v = 0$, $J = 1$; $M_J = 0 \rightarrow |M_J| = 1$ yields $eqQ = 7.3 \pm 0.4$ kc. Comparison of the coupling constants in $Li^6F$ and $Li^7F$ gives the ratio quadrupole moments of the two stable lithium isotopes to be $Q(Li^6)/Q(Li^7) = +0.0176 \pm 0.001$. This value is in good agreement with the earlier determination of sign by Kusch and magnitude by Cranna. Combining the measured quadrupole coupling constant in LiH with the electric field gradient calculated by Nesbet and Kahalas yields the nuclear quadrupole moments $Q(Li^6) = -8.0 \times 10^{-28}$ cm$^2$ and $Q(Li^7) = -4.5 \times 10^{-26}$ cm$^2$. The errors in both quadrupole moments are estimated to be ±10%. (auth)

**7754** THEORY OF THE ANHARMONICITY IN THE VIBRATIONAL MOTION OF EVEN-EVEN SPHERICAL NUCLEI. Giu Do Dang and Abraham Klein (Univ. of Philadelphia). Phys. Rev., 133: B257-67(Jan. 27, 1964).

By extending a method developed recently for the electron gas problem to the case of even-even spherical nuclei, corrections to the random phase or harmonic description of the vibrational spectrum were obtained. The calculation, which was based on the conventional pairing plus quadrupole force effective hamiltonian, indicates a systematic sequence of higher approximations taking into account successively more complicated phonon-phonon and phonon-quasiparticle pair interactions. The approximation, which includes only the leading phonon-phonon interaction in its effect on the one and two phonon states, is in principle rich enough to allow all of the observed orderings of the two phonon triplet. The case of $Ni^{62}$ was studied in detail, with all parameters except the strength of the quadrupole force taken directly from the work of Kisslinger and Sorensen and the latter constant readjusted so that the improved theory gives the energy of the first $2^+$ state. A parameter-free accord to the ordering $(0^+, 2^+, 4^+)$ of the two phonon state is obtained, though the energies are on the whole high. The main defects of the calculation are discussed. (auth)

**7755** EMPIRICAL RULES FOR PREDICTING GROUND-STATE SPINS OF LIGHT NUCLEI. Tannie Stovall (National Bureau of Standards, Washington, D. C.). Phys. Rev., 133: B268-9(Jan. 27, 1964).

Empirical rules are given that predict the ground-state spin of light nuclei. Possible theoretical justifications for the rules are discussed. (auth)

**7756** INCLUSION OF FINITE NUCLEAR SIZE EFFECTS IN THE ANALYSIS OF BETA-GAMMA DIRECTIONAL CORRELATION MEASUREMENTS IN $La^{140}$ AND $Ga^{72}$. R. W. Newsome, Jr. and H. J. Fischbeck (Univ. of Michigan, Ann Arbor). Phys. Rev., 133: B273-80(Jan. 27, 1964).

The β-γ directional correlation in the first forbidden $3^- \rightarrow 2^+$ β transitions of $La^{140}$ and $Ga^{72}$ was measured as a function of energy. A search for the nuclear matrix element parameters Y, x, and u, which are compatible with the experimental results, was conducted. Finite nuclear size effects were included in the analysis by using the electron radial wave functions from the tables of Bhalla and Rose. (auth)

**7757** ELECTRIC QUADRUPOLE TRANSITIONS IN ODD-MASS SPHERICAL NUCLEI. Raymond A. Sorenson (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 133: B281-4(Jan. 27, 1964). (BNL-7327)

The wave functions derived by Kisslinger and Sorensen from the pairing plus quadrupole force model for atomic nuclei are used to compute theoretical E2 electromagnetic transition rates between various low lying states in odd-mass spherical nuclei from Ni to Pb. Comparison is made with experimental data where available. The agreement between theory and experiment is quite good, a large majority of the forty or so cases agreeing within a factor of two while the data cover a range of more than a factor of one thousand. (auth)

**7758** SPIN-$23/2^-$ ISOMER OF $Lu^{177}$. P. Alexander, F. Boehm, and E. Kankeleit (California Inst. of Tech., Pasadena). Phys. Rev., 133: B284-90(Jan. 27, 1964).

Investigations of the decay of the three-particle state in $Lu^{177}$ with spin $^{23}/_2^-$ performed with the crystal diffraction

technique revealed evidence for three-particle states in $Hf^{177}$ and rotational bands in $Lu^{177}$ and in $Hf^{177}$. Levels with spins to $^{17}/_2$ were found in the $K = {}^7/_2{}^+$ rotational band in $Lu^{177}$ while the $K = {}^7/_2{}^-$ and $K = {}^9/_2{}^+$ bands in $Hf^{177}$ were found to be excited up to spin $^{21}/_2$ levels. From energy and intensity measurements of the cascade, crossover, and interband transitions, the values of a number of parameters pertinent to the collective model were derived. In particular, it was verified for each of the rotational bands that the quantity $(g_K - g_R)/Q_0$ was a constant within the experimental error. (auth)

**7759** DECAY SCHEME OF $Fm^{255}$. F. Asaro, S. Bjoernholm, and I. Perlman (Univ. of California, Berkeley). Phys. Rev., 133: B291-300(Jan. 27, 1964). (UCRL-10635)

The alpha decay scheme of $Fm^{255}$ was investigated by alpha particle, gamma ray, and electron spectroscopy. Nine alpha groups were observed with alpha-particle energies and abundances of: 7.122, (0.09 ± 0.01)%; 7.098, (0.10 ± 0.01)%; 7.076, (0.43 ± 0.05)%; 7.019, (93)%; 6.977, (0.11 ± 0.02)%; 6.960, (5.3 ± 0.1)%; 6.887, (0.60 ± 0.03)%; 6.803, (0.12 ± 0.02)%; and 6.58 Mev, $(4.5 \pm 0.9) \times 10^{-2}$%. The ground state of $Cf^{251}$ was assigned a spin of $^1/_2$ and is probably the $^1/_2$ + [620↑] Nilsson state. Five members of the rotational band based on the ground state were observed. The value of the decoupling parameter a, is 0.24 ± 0.03, and $\hbar^2/2F$ has a value of 6.4 ± 0.3. The ground state of $Fm^{255}$ decays by an unhindered alpha transition to a 106-kev state in $Cf^{251}$. Both of these states are assigned a spin of $^7/_2$ and are presumably the $^7/_2$ + [613↑] Nilsson state. Four members of the rotational band based on the 106-kev state in $Cf^{251}$ were observed, and their energies correspond to a value of $\hbar^2/2F$ of 6.69 ± 0.03. The 106-kev state with the $^7/_2$ + [613↑] assignment has a half-life of $(3.7 \pm 0.2) \times 10^{-8}$ sec. The gamma rays that de-excite this state to the ground-state band are thought to originate through a multiple Coriolis interaction between two states 0.56 kev apart. Two other intrinsic levels in $Cf^{251}$ were detected. One at 546 kev was given the assignment of $^{11}/_2$ − [725↑] and the other, tentatively at 425 kev, was given the assignment $^1/_2$ + [615↑]. The appropriate alpha transition probabilities for the decay to the various states agree well with the expectations for unhindered and hindered alpha decay. (auth)

**7760** REFERENCE SPECTRUM METHOD FOR THE BOUNDARY-CONDITION MODEL OF NUCLEAR FORCES. M. Razavy (Univ. of Alberta, Edmonton) and Donald W. L. Sprung. Phys. Rev., 133: B300-9(Jan. 27, 1964).

The reference spectrum method of Bethe, Brandow, and Petschek for the calculation of the ground-state properties of nuclear matter is applied to the boundary-condition model of Feshbach and Lomon for the two-nucleon interaction. The short-range contribution to the reference G matrix is evaluated analytically, and the formulas needed for evaluation of the outer contribution given. The method is applied to a simple model interaction (boundary condition plus square well acting in S states only) and results compared with those from typical hard-core potentials. The correction terms to the reference approximation are found to be about one Mev per particle. The important region of intermediate state momenta in which the reference spectrum should be fitted, is again found to be near 4 $F^{-1}$. (auth)

**7761** ISOBARIC YIELD DISTRIBUTIONS IN THE INTERACTION OF 1.8-Gev PROTONS WITH $Zr^{96}$, $Mo^{96}$, AND $Ru^{96}$. Norbert T. Porile and Larry B. Church (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 133: B310-17(Jan. 27, 1964). (BNL-7296)

Cross sections for the formation of 4 isobars with A = 72 in the interaction of 1.8-Bev protons with $Zr^{96}$, $Mo^{96}$, and $Ru^{96}$, were measured. Results were also obtained for a number of other nuclides with A = 66–74. It is found that the charge of the most probable product with A = 72 increases by 0.6 units in going from $Zr^{96}$ to $Ru^{96}$, resulting in large differences in isobaric yield ratios for the different targets. These results are in qualitative agreement with cascade-evaporation calculations. A strong correlation between the peak position in the isobaric yield curve and the target N/Z value is indicated both by these results and previous measurements by Kaufman for a number of heavier targets. (auth)

**7762** ELASTIC SCATTERING OF PROTONS BY $Fe^{56}$, $Fe^{58}$, AND $Ni^{58}$ AT 10.9 AND 11.7 Mev. J. Benveniste (Univ. of California, Livermore), A. C. Mitchell, and C. B. Fulmer. Phys. Rev., 133: B317-22(Jan. 27, 1964).

Differential cross sections for elastic scattering of protons from $Fe^{56}$, $Fe^{58}$, and $Ni^{58}$ were measured and compared. Differences in positions of the maxima and minima are observed; when compared with the results of extensive optical model analyses of other data these are shown to be consistent with a nuclear symmetry dependence of the real nuclear-potential well depth. A comparison of the A = 58 data with previously reported A = 64 data shows the positions of maxima and minima in the differential elastic-scattering cross sections to be much more sensitive to differences of (N − Z)/A than to differences in nuclear deformation. (auth)

**7763** PROTON SCATTERING BY ISOBARS AND SINGLE ISOTOPES. J. Benveniste (Univ. of California, Livermore), A. C. Mitchell, B. Buck, and C. B. Fulmer. Phys. Rev., 133: B323-9(Jan. 27, 1964).

Differential cross sections for proton inelastic scattering to the first excited (2+) states of $Fe^{56}$, $Fe^{58}$, $Ni^{58}$, $Ni^{64}$, and $Zn^{64}$ are reported for bombarding energies near 10 Mev. Elastic- and inelastic-scattering angular distribution data were analyzed by a recently reported generalization of the optical model in which states of quadrupole collective motion strongly coupled to the nuclear ground state are considered. The results of this analysis show a dependence of the real nuclear potential depth on the nuclear symmetry parameter (N − Z)/A; the symmetry term for the real potential was found to be ~[23(N − Z)/A] Mev. (auth)

**7764** PARITY NONCONSERVATION IN NUCLEI. F. Curtis Michel (California Inst. of Tech., Pasadena). Phys. Rev., 133: B329-49(Jan. 27, 1964).

The influence of the known weak interactions on the parity of nuclear states is discussed. Derivation of a parity nonconserving interaction rests on the assumption of a current-current hypothesis for the weak interactions. Consequently, observation of parity impurity effects would be an important confirmation of this hypothesis. A simple approximate method of treating the nuclear parity impurity is developed and applied in an effort to find experimental situations favorable to observation of effects due to such impurity. Parity-forbidden alpha decay from excited states of light nuclei and certain electromagnetic transitions in the heavy nuclei appear to be promising. Special attention was paid to the internal conversion electrons from the 123-kev transition in $Lu^{173}$ whose polarization is estimated to be about 0.4%. An effect on polarized neutrons analogous to optical rotation is also discussed. (auth)

**7765** SOME (d,α) REACTIONS ON $Be^9$, $F^{19}$, AND $Al^{27}$ AT 27.5 Mev. S. Mayo, J. Testoni and O. M. Bilaniuk (Comisión National de Energía Atómica, Buenos Aires). Phys. Rev., 133: B350-2(Jan. 27, 1964).

The angular distributions of absolute cross sections were measured for (d,$\alpha$) reactions at 27.5 Mev leading to the final states: 4.63 and 7.47-Mev in $Li^7$; ground and 0.872-Mev in $O^{17}$; ground, 1.61 and 3.399 plus 3.408-Mev in $Mg^{25}$. Measurements were carried out in the angular range from 15 to 120 lab deg, in 5-deg intervals for the forward, and 10-deg intervals for the backward hemisphere. A solid-state detecting system with a resolution in energy of about 1% was used. The angular distributions show pronounced forward peaking. Comparison is made with cross sections computed, in plane-wave Born approximation, for double pickup and knockout mechanisms. (auth)

**7766** NUCLEAR LEVELS OF $F^{20}$. Carl T. Hibdon (Argonne National Lab., Ill.). Phys. Rev., 133: B353-69 (Jan. 27, 1964).

The nuclear levels of $F^{20}$ were investigated at neutron energies from about 1 to 300 kev. Only a few resonances can be attributed to s-wave levels, the remaining ones that can be analyzed being attributable to p-wave levels. The two resonances near 27 and 49 kev were investigated extensively and can be attributed to p-wave levels. However, the former assumption of mutual interference between this pair of levels was ruled out because their spins of 2 and 1, respectively, appear to be well determined and each resonance exhibits an asymmetrical shape that is just the reverse of what it should be for mutual interference. The cluster of resonances near 100 kev appears to consist of three p-wave levels (one each with J = 0, 1, and 2) and a fourth resonance attributable to an s-wave level. Two other small peaks occur on the high-energy side of the cluster. For the levels that could be analyzed, the s-wave strength function was found to be small and the p-wave one very large. The measurements were made by the method used previously, but the analysis included some recently developed methods. (auth)

**7767** THE $Ta^{181}$(d,p)$Ta^{182}$ REACTION AND A BAND-MIXING ANALYSIS OF THE OBSERVED ENERGY LEVELS. J. R. Erskine (Argonne National Lab., Ill. and Massachusetts Inst. of Tech., Cambridge) and W. W. Buechner. Phys. Rev., 133: B370-7(Jan. 27, 1964).

The multiple-gap magnetic spectrograph was used to investigate the $Ta^{181}$(d,p)$Ta^{182}$ reaction at a bombarding energy of 7.0 Mev. Numerous energy levels up to an excitation energy of about 2.5 Mev in $Ta^{182}$ were observed with an 8-kev resolution width. A ground-state Q value of 3.832 ± 0.008 Mev was measured. The model of a rotator plus two odd nucleons was used in calculations in an attempt to interpret the observed energy levels. The effects of Coriolis band mixing were included in the calculation. An acceptable fit was obtained for the lower excited states under the assumption that the stripped neutron entered the ($510\frac{1}{2}^-$), ($512\frac{3}{2}^-$), and ($503\frac{7}{2}^-$) Nilsson orbits. (auth)

**7768** NEUTRON-INDUCED FISSION CROSS SECTION OF $Pu^{241}$ BELOW 11 ev. T. Watanabe and O. D. Simpson (Phillips Petroleum Co., Idaho Falls, Idaho). Phys. Rev., 133: B390-1(Jan. 27, 1964).

The cross section for neutron-induced fission of $Pu^{241}$ for neutron energies below 11 ev was determined. The determination was made using a gas scintillation counter. The multilevel analysis of these data is in agreement with that predicted from the previous analysis of the total cross section. (auth)

**7769** ENERGY SPECTRA OF NEUTRONS EMITTED FOLLOWING $\pi^-$ CAPTURE IN C, Al, Cd, Pb, AND U. H. L. Anderson, E. P. Hincks, C. S. Johnson, C. Rey, and A. M. Segar (Univ. of Chicago). Phys. Rev., 133: B392-403 (Jan. 27, 1964).

The neutron emission from the capture of stopped mesons($\pi^-$) in C, Al, Cd, Pb, and U was studied using a time-of-flight detector. The energy spectra are characterized by a low-energy evaporation part, and a high-energy component due to the direct neutron emission. The general features of the direct neutron emission are similar for all the substances studied, with approximately 2 neutrons per $\pi^-$ capture. In contrast, the relative yield of the low-energy component increases markedly in the heavier nuclei. The neutron multiplicities in energy range from about 1.8 to 150 Mev were 2.8 ± 0.3, 3.2 ± 0.3, 3.6 ± 0.4, 3.5 ± 0.4, and 5.0 ± 0.5, for C, Al, Cd, Pb, and U, respectively. The total kinetic energy in neutron emission was about 68, 74, 80, 69, and 100 Mev for C, Al, Cd, Pb, and U, respectively. In the case of Cd the data are sufficiently complete to give a good account of the energy balance. (auth)

**7770** NEUTRON TRANSFER IN $N^{14}(N^{14},N^{13})N^{15}$ AT LOW ENERGIES. G. Breit, K. W. Chun, and H. G. Wahsweiler (Yale Univ., New Haven). Phys. Rev., 133: B403-8(Jan. 27, 1964). (TID-19334)

Formulas concerned with approximate quantum-mechanical corrections to the semiclassical treatment of the neutron transfer reaction previously contained or implied in the literature are extended and put in a more convenient form for application. New data of McIntyre, Jobes, and Becker in the laboratory energy range 9.0 to 18.0 Mev are compared with theoretical expectation. The accuracy of a previous discussion of 18-Mev data is improved. At 18 and at 12.6 Mev reasonable agreement with experimental angular distributions is found close to 90° in the c.m. system. At smaller angles the experimental values of the cross section are below those calculated at 18 Mev, in agreement with the influence of absorption on the recoils suggested for this case by McIntyre and Jobes; at 12.3 Mev the experimental values are somewhat smaller than the theoretical as would be the case in the presence of virtual Coulomb excitation (VCE). Total transfer cross sections show a systematic increase over expectation by a factor of about 2.9 between 9.0 and 12.8 Mev as though some VCE were present. The calculated ratio of the 90° cross section at 18 Mev to that at 12.6 Mev is about 10 times that observed. Possible explanations of this discrepancy are discussed. (auth)

**7771** POLARIZATION AND DIFFERENTIAL CROSS SECTION OF NEUTRONS SCATTERED FROM $Be^9$: PARITIES OF THE 7.37- AND 7.54-Mev STATES IN $Be^{10}$. R. O. Lane, A. J. Elwyn, and A. Langsdorf, Jr. (Argonne National Lab., Ill.). Phys. Rev., 133: B409-19(Jan. 27, 1964).

The polarization and the differential scattering cross sections for neutrons scattered from $Be^9$ were measured at 5 angles for neutron energies from 0.2 to 2.0 Mev. The data are interpreted in terms of a two-channel process. The neutron scattering resonances at 0.625 and 0.815 Mev, corresponding to levels in $Be^{10}$ at 7.37 and 7.54 Mev, were assigned the spin and parity values $J^\pi = 3^-$ (l = 2) and $J^\pi = 2^+$ (l = 1), respectively. The calculations took account of the effects of s-wave and p-wave backgrounds as well as approximate contributions of $1^-$ and $2^-$ bound states. (auth)

**7772** TARGET-MOMENTUM AND NONLOCAL EFFECTS IN THE HIGH-ENERGY OPTICAL POTENTIAL. R. E. Schenter and B. W. Downs (Univ. of Colorado, Boulder). Phys. Rev., 133: B522-8(Jan. 27, 1964).

A derivation of the optical potential for elastic scattering of high-energy nucleons by heavy nuclei is given under the

multiple-scattering and impulse approximations. The momenta of the target nucleons and the dependence of the nucleon-nucleon scattering matrix on the sum p and difference q (momentum transfer) of final and initial relative momenta in the two-body center-of-mass system are taken into account in this derivation, and their effects are emphasized. The momenta of the target nucleons and the p dependence of the nucleon-nucleon scattering matrix, which are usually neglected in such derivations, introduce nonlocal terms in the optical potential. The contributions to this optical potential, which arise from the one-pion exchange and phenomenological parts of the nucleon-nucleon scattering matrix, are discussed. When the optical potential is used to describe scattering in Born approximation, the nonlocal terms have the effect of energy-dependent multiplicative operators. In particular, target-momentum effects lead to terms that, in Born approximation, can be readily interpreted as energy-dependent distortions of the optical potential in the direction of the momentum of the incident nucleon. (auth)

**7773** FREQUENCY SHIFTS IN SPIN-EXCHANGE OPTICAL PUMPING EXPERIMENTS. L. C. Balling, R. J. Hanson, and F. M. Pipkin (Harvard Univ., Cambridge, Mass.). Phys. Rev., 133: A607-26(Feb. 3, 1964).

A theory is derived to predict the density matrices describing two atoms after a spin-exchange collision from the density matrices before the collision and the scattering amplitude for binary collisions. This theory is then applied to a system of quasifree electrons interacting with optically pumped rubidium atoms. For calculating the change in the electron density matrix, the $Rb^{85}$ and $Rb^{87}$ are replaced by a fictitious rubidium isotope with no nuclear spin. Expressions are derived for the change in the light transmission when a radio-frequency field is present at the electron frequency. In addition to the linewidth for the electron signal, the spin-exchange theory predicts a frequency shift the magnitude of which depends upon the two-body scattering amplitude, the rubidium polarization, and the rubidium density. Experiments performed to test various aspects of the theory are reported. The measurements were made on a system of quasifree electrons interacting with rubidium atoms. Measurements of the electron linewidth as a function of temperature indicated that spin-exchange collisions dominated the electron relaxation. The predicted frequency shift was measured by observing the electron resonance frequency first with left circularly polarized light and then with right circularly polarized light. For electrons colliding with rubidium atoms the shift is negative when the rubidium polarization is positive and the ratio of the shift to the linewidth is $\delta\nu_0/\Delta\nu = -0.025 \pm 0.005$. From the measured values of the shift and the linewidth, a value is derived for the electron-rubidium spin-flip cross section. The replacement of $Rb^{85}$ and $Rb^{87}$ by the fictitious rubidium isotope with no nuclear spin is justified. The calculations for the simple electron-rubidium system are generalized and applied to more complicated systems. Results are reported for the change in the density matrix of hydrogen atoms when they collide with polarized electrons, the change in the density matrix of $Rb^{87}$ atoms when they collide with polarized electrons, and the change in the density matrix of hydrogen atoms when they collide with hydrogen atoms. (auth)

**7774** YTTERBIUM NMR: $Yb^{171}$ NUCLEAR MOMENT AND Yb METAL KNIGHT SHIFT. A. C. Gossard (Centre d'Études Nucléaires, Saclay, France and Bell Telephone Labs., Murray Hill, N. J.), V. Jaccarino, and J. H. Wernick. Phys. Rev., 133: A881-4(Feb. 3, 1964).

The nuclear magnetic resonance of $Yb^{171}$ was found in two nonmagnetic ytterbium compounds, $YbCl_2$ and YbS, from which a value of $\mu^{171} = +0.4926 \pm 0.0004\ \mu_N$ is determined. From the $Yb^{3+}$ electron paramagnetic resonance measurements of the ratio of the hfs constants $A^{171}/A^{173}$ it is found that $\mu^{173} = -0.6772 \pm 0.0025\ \mu_N$. Observations of $Yb^{171}$ NMR in elemental Yb metal and in the intermetallic compound $YbAl_2$ at temperatures of 1.8, 4.2, and 20.4°K yield values of the Knight shift of $(0.0 \pm 0.1)\%$, and $(7.76 \pm 0.05)\%$, respectively. The absence of any detectable temperature dependence of the field for resonance indicates that the low-temperature increase in the magnetic susceptibilities of these metals is caused by isolated, localized magnetic impurities. In $YbAl_2$, a constant susceptibility of $7.6 \times 10^{-4}$ emu/mole remains at higher temperatures. The electronic contribution to the specific heat is found to be $\gamma \cong 4 \times 10^{-3}$ cal/mole °K$^2$. The nuclear spin-lattice relaxation time $T_1 \cong 0.12/T$ sec at T = 1.8°K. From these latter two measurements, in conjunction with the large positive Knight shift, it is concluded that the larger part of the high-temperature $\chi$ does not arise from spin paramagnetism of the band electrons, but is orbital in origin. (auth)

**7775** CHARACTERISTIC K-SHELL X-RAY PRODUCTION IN MAGNESIUM, ALUMINUM, AND COPPER BY 60- TO 500-kev PROTONS. J. M. Khan and D. L. Potter (Univ. of California, Livermore). Phys. Rev., 133: A890-4 (Feb. 3, 1964). (UCRL-7454)

Characteristic K-shell x rays produced when protons of 60- to 500-kev energy are stopped in thick targets of magnesium, aluminum, and copper were studied using a proportional counter of conventional design. The thick target yields were measured. The x-ray production cross sections were calculated for the K shells. Ionization cross sections were estimated and were found to be smaller than the values predicted by the Born approximation in all cases. (auth)

**7776** THE 2.21 Mev LEVEL OF $^{27}$Al. C. Van der Leun (Rijksuniversiteit, Utrecht). Physica, 29: 1155-64 (Nov. 1963).

In order to test a suggested interpretation of the $Al^{27}$ level scheme on the basis of the collective rotational model, the spin and parity of the 2.21-Mev level of $Al^{27}$, and the mixing ratio of the gamma ray de-exciting this level, were determined. At the $E_p$ = 1966, 1548, and 1249 kev resonances in the reaction $Mg^{26}(p,\gamma)Al^{27}$, gamma-gamma angular correlations of cascades through this level were measured. Analysis of the data yields an unambiguous assignment J = 7/2 to $Al^{27*}$ (2.21), whereas the quadrupole/dipole mixing ratio of the 2.21-Mev $\gamma$ ray, x = 0.394 ± 0.013, entails even parity. This $J^\pi = 7/2^+$ assignment is in agreement with the collective model interpretation of the $Al^{27}$ level scheme. (auth)

**7777** MEASUREMENT OF $(n,\gamma)$ CROSS SECTIONS OF Na-22 AND Co-58. U. Farinelli and M. Martini (CNEN, Casaccia, Italy). Physica, 29: 1196(Nov. 1963).

The cross sections for the absorption of pile neutrons in the two radioactive nuclides $Co^{58}$ and $Na^{22}$ were measured by a source depletion method. (R.E.U.)

**7778** EXCITATION FUNCTIONS FOR ALPHA-INDUCED REACTIONS ON GOLD. R. E. Van de Vijver (Instituut voor Kernphysisch Onderzoek, Amsterdam). Physica, 29: 1214-18(Nov. 1963).

The excitation functions of $Au^{197}(\alpha,xn)$ reactions were measured by a stacked-foil method. For 52-Mev alpha particles, x can be as high as 5. The sum of the cross sections of the competing $(\alpha,xn)$ reactions is within the errors equal to the reaction cross section as was calculated by Huizenga and Igo for $Pt^{195}$. (auth)

**7779** ON NUCLEON-$He^4$ INTERACTION AND NUCLEAR FORCES. Hiroyuki Kanada, Sinobu Nagata, Shoichiro Otsuki, and Yoshio Sumi (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 30: 475-93(Oct. 1963).

The nucleon-$He^4$ elastic scattering at the incident energies from 0 to 40 Mev is investigated in relation to the nuclear forces. The s-, p-, d-, and f-wave phase shifts are calculated by the nucleon-$He^4$ interaction, that is constructed from an approximated Hamada and Johnston nucleon-nucleon potential. The differential cross section and the polarization angular distribution calculated by these phase shifts are compared with the experimental data. All essential features of the nucleon-$He^4$ scattering are explained in the energy region where the inelastic cross section is negligible. Especially the polarization at 40 Mev is fairly reproduced, which is attributed to very small (and negative) values of the d-wave phase shifts. The nucleon-$He^4$ interaction depends drastically on the energy and the state, as the result of the presence of large non-local interaction. The nucleon-$He^4$ spin-orbit coupling is constructed from the tensor and the spin-orbit part of the nucleon-nucleon forces. It is probable that the strength of the original spin-orbit force is rather weaker at low energies than that known from the high energy proton-proton scattering. (auth)

**7780** ANGULAR CORRELATION IN INELASTIC NUCLEON SCATTERING. Eric Sheldon (Eidgenössische Technische Hochschule, Zürich). Rev. Mod. Phys., 35: 795-853(Oct. 1963).

Angular correlations for neutron and proton inelastic scattering from medium-heavy nuclei are considered. Scattering at low energies for which the compound-nucleus mechanism is predominant is investigated. Analysis on the basis of distorted-wave direct-interaction theory for scattering at high energies is also presented. The formulation of scattering theory generalized to take account of spin-orbit interaction is described. (C.E.S.)

**7781** ELASTIC SCATTERING OF PROTONS ON LEAD NUCLEI AT 19.2 Bev/c. H. Goeing (Max-Planck-Institut für Physik und Astrophysik, Munich). Z. Naturforsch., 18a: 1182-4(Nov. 1963). (In German)

The well-collimated 19.2-Bev/c CERN proton beam hit a Pb target. Small emulsions behind the target measured the angular distribution of scattered protons between 0.1 and 0.6°. This distribution yielded a radius of interaction $R = 5.6 \times 10^{-13}$ cm for Pb nuclei. The differential cross section for elastic nuclear scattering in the forward direction was found to be $\sigma(0°) = 2.15 \times 10^5$ barn/ster. These results were compared with those obtained by other authors. (auth)

**7782** THE THERMAL-NEUTRON CAPTURE CROSS SECTION OF $Cd^{108}$ AND THE DECAY OF $Ag^{109m}$. H. W. Boyd (Vanderbilt Univ., Nashville), J. H. Hamilton, A. R. Sattler, and P. F. A. Goudsmit. 5p. (CONF-328-5)

From American Physical Society Southeast Section 1963 Spring Meeting, Knoxville, Tenn., Apr. 1963.

In studies of $Ag^{108m}$ and $Ag^{110m}$ produced by thermal-neutron capture in natural silver, 88.0-kev transition was observed. The K : L : M ratios of 95 ± 3 : 100 : 20 ± 5 are in good agreement with the theoretical values for an 88-kev E3 transition. This transition was identified as the 40-sec isomeric one in $Ag^{109m}$. The production is $Ag^{107}(n,\gamma)$ $Ag^{108}(\beta^-)$ $Cd^{108}(n,\gamma)$ $Cd^{109}$(electron capture) $Ag^{109m}$. The thermal neutron capture cross section of $Cd^{108}$ was calculated to be 24 ± 10 barns. (auth)

**7783** $Cr^{53}(n,\gamma)Cr^{54}$ REACTION. M. R. Gunye and G. A. Bartholomew (Atomic Energy of Canada, Ltd., Chalk River, Ont.). 15p. (CONF-346-4)

From International Conference on Nuclear Physics with Reactor Neutrons, Argonne, Ill., Oct. 1963.

Detectors were 3 × 3 in. NaI spectrometers and the target was 4.2 grams of $Cr_2O_3$ enriched to 95.2% in $Cr^{53}$. Fast-slow coincidence circuits, pulse-adding circuits, and pulse-height stabilizers are included for each detector. The neutron beam was $10^6$ n/cm sec. (R.E.U.)

**7784** ISOBARIC NUCLEI WITH THE MASS NUMBER A = 73. E. P. Grigor'ev. A Pergamon Press Book. Translated by Prasenjit Basu from "Izobarnyye Yadra s Massovym Chislom A = 73." International Series of Monographs on Nuclear Energy. Division II. Nuclear Physics. Volume 11. New York, The Macmillan Company, 1963. 54p.

Decay schemes, energy levels, half lives, emission spectra, and other nuclear properties of the radioisotopes $Ga^{73}$, $As^{73}$, and $Se^{73}$ are given. The properties of the ground and excited energy levels of the stable isotope $Ge^{73}$ are also presented. Bibliographies are included for each of the four isotopes. (C.E.S.)

**7785** SYSTEMATICITY OF NUCLEI FROM $O^{16}$ TO $Ca^{40}$. Kh. E. Gouv. P.187-203 of "Stroenie Yadra." Moscow, Atomic Publishing House, 1962.

The properties of nuclear levels were considered between $O^{16}$ and $Ca^{40}$. It is shown that within 1d–2s shell the values of the internal quadrupole moment and deformation parameters of nucleus are at a maximum when nuclear mass is between 20 and 27 with sharp transition from positive to negative values in the vicinity of mass number 30 and 25, respectively. The properties of excited nuclear states are discussed in detail corresponding to 1d–2s shell. For nuclei with odd A on examples of nuclei with 9, 11, 13, and 15-th last unpaired particle good agreement is shown between the levels of sd-shell and Nielson model by comparing calculated and measured positions of levels. Experimental data on the levels of even-even nuclear sd-shells were considered on the basis of which certain generalizations have been made regarding the positions of levels and types of models. (Referativnyy Zhurnal, Khimiya, No. 13, 1963)

**7786** NUCLEAR FISSION AND STRUCTURE. D. Zh. Griffin. p.309-22 of "Stroenie Yadra." Moscow, State Atomic Publishing House, 1962.

The analogy is made between the stable deformed nucleus and a nucleus which passes through a potential barrier in the course of fusion process. In the case of slow neutron induced fission the theory permits the assumption of resonance splitting into two groups with different average widths, depending on spin of the resonance state. It follows from the theory that mass asymmetry of fragments depends on the vibrational level of nucleus at which the nucleus overcomes the fission potential barrier. Consideration of the latter experimental data leads to disagreement with the theory. In fast particle induced fission the most interesting is anisotropy of fission fragments. In the case of high excitation energy (>15 Mev above fission threshold) the experiment agrees well with conclusions of statistical model. In the case of lower excitation energies experimental data disagree with calculations of statistical model. Correction for various effects of paired interactions in the nucleus gives good agreement with the experiment. (Referativnyy Zhurnal, Khimiya, No. 13, 1963)

# Plasma Physics and Thermonuclear Processes

**7787** (AEDC-TDR-63-242) SUMMARY OF ELECTRICAL PROPULSION DIAGNOSTIC INSTRUMENTATION. James B. Whited (Arnold Engineering Development Center, Tullahoma, Tenn.). Oct. 1963. Contract AF40(600)-1000. 38p.

The instrumentation development effort initiated to effect plasma diagnostics during the long-term testing of electrical propulsion systems is summarized. Two different ion beam sources were instrumented to obtain the basic properties of the plasma, such as the electron temperature, electron and ion densities, and the space charge potentials. The basic instrumentation required to effect preliminary diagnostics are the "plasma eater," the positive ion probe, the Langmuir double probe, the Faraday cup, and the emissive probe. With these devices, it is possible to obtain both integral and differential measurements of the beam characteristics. Analysis of the data is also included. (auth)

**7788** (CEA-2351) ETUDE DE L'OPERATEUR D'INTERACTION ENTRE DEUX GROUPES DE PARTICULES DANS UN PLASMA COMPLETEMENT IONISE. DEVELOPPEMENT DES FONCTIONS DE DISTRIBUTION EN SERIES DE POLYNOMES ORTHOGONAUX (theses). (Study of the Interaction Operator Between Two Groups of Particles in a Completely Ionized Plasma. Development of the Distribution Functions in a Series of Orthogonal Polynomials (thesis)). A. Fain (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 80p.

A completely ionized medium is considered in which the variations of the distribution functions for each species is governed by the Fokker-Planck equation. The interaction operator is of a form given by Rosenbluth-MacDonald-Judd. The distribution functions are expanded into orthogonal polynomial series in the velocity space. In a first stage these functions are split up into spherical harmonic series or, in an equivalent form, into series of scalar products of irreducible cartesian tensors, with coefficients that are a function of the velocity modulus as well as space and time coordinates. In the second stage these coefficients are expanded into series of orthogonal functions of the velocity modulus; the first-order harmonic is represented by the product of a Maxwellian distribution and of a Sonine polynomial series, having an index of $1 + \frac{1}{2}$, which has as variable the reduced energy of the particles (in terms of a basic temperature), with coefficients that then only depend on the space and time coordinates. The relation is established between the expansion coefficients and the moments of the distribution function, as well as the hydrodynamic values. The expansion, using spherical harmonics, is applied to the Fokker-Planck equation. The general expression for the second member is given as well as the particular expressions corresponding to the cases where the operator is linearized. The complete expansion in orthogonal polynomial series is applied to the Fokker-Planck equation. The expression of the generating functions is given for all the harmonics in the case of the linearized operator, as well as the transport equations for the first four harmonics. (auth)

**7789** (NP-13428) SUMMARY OF SHERWOOD ACTIVITIES. (Defense Atomic Support Agency. Field Command, Albuquerque, N. Mex.). Aug. 15, 1963. 89p.

The status of research at the institutions participating in SHERWOOD is summarized. The experimental devices and the research in progress are described. (D.C.W.)

**7790** (PWA-2133) INVESTIGATION OF MAGNETOHYDRODYNAMIC POWER GENERATION. VOLUME V. THEORETICAL PLASMA CONDUCTIVITY STUDIES. Final Report. (Pratt and Whitney Aircraft Div., United Aircraft Corp., Hartford, Conn.). Jan. 1963. Contract AF30(602)-2487. 198p. (RADC-TDR-62-464(Vol.V))

The formulas for the electrical conductivity and diffusion coefficients of a magnetohydrodynamic generator plasma including ion flow are derived. The electron energy equation is developed leading to an expression for electron temperature. These formulas are applied to segmented and unsegmented MHD generators. It is shown that in segmented generators these quantities have much more favorable values. The expressions derived are also compared to the approximate relations based on a constant electron collision frequency. It is shown that the approximate relations can lead to inaccurate results, especially in the Hall mobility ratio. The MHD electrode boundary layer is investigated to find the electrode voltage drop. The electron and ion continuity and current and energy equations across the boundary layer are formulated. Due to time limitations, simplified forms of these equations are solved simultaneously with the integral form of the gas continuity, momentum and energy relationships. This leads to profiles of the electric field, electron density, and electron temperature. The electric field is integrated across the boundary layer to find the voltage drop per unit boundary layer thickness. The rate of growth of the boundary layer is also investigated in order to get absolute values on the voltage drop. It is found that the cathode voltage drop is dependent on the gas temperature profile near the wall. Devices such as roughening or wedges that lead to higher initial temperature gradients should appreciably lower the voltage drop. 44 references. (auth)

**7791** (JPRS-21869(p.108-28)) RADIATION OF A CHARGE IN AN INHOMOGENEOUS MEDIUM WITH SPATIAL DISPERSION. V. V. Tamoykin. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 6: 257-66(1963).

Expressions are obtained for the intensity and for the angular distribution of the fluctuation of transverse (electromagnetic) waves and also longitudinal (plasma) waves up to and beyond the threshold of the Cherenkov radiation from the plasma waves. (R.E.U.)

**7792** (JPRS-21869(p.190-213)) SPATIAL CORRELATION OF FLUCTUATION ELECTROMAGNETIC FIELD IN A PLASMA. PART I. V. F. Aleksin and K. N. Stepanov. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 6: 297-310(1963).

The correlation functions of frequency components of fluctuating electric and magnetic fields in a magnetoactive plasma are obtained. It is shown that in the transparency band, when the damping is sufficiently small, the correlation functions are equal to $r^{-1} \exp(-\chi r)$, where $2\chi$ is the damping factor of plane waves whose group velocity is parallel to the distance r. (auth)

**7793** (JPRS-21869(p.403-10)) CONCERNING ONE TYPE OF BEAM INSTABILITY IN A PLASMA. A. A. Rukhadze. Translated from Izv. Yvsshikh Uchebn. Zavedenii, Radiofiz., 6: 401-3(1963).

The beam instability connected with the excitation of the longitudinal component of the electric field is discussed. It is shown that a beam of charged particles in an isotropic plasma can cause excitation of the purely transverse com-

ponent. The study is confined to waves propagating transversely to the beam. (R.E.U.)

**7794** (MATT-Trans-10) EFFECT OF A TRANSVERSE MAGNETIC FIELD ON A TOROIDAL DISCHARGE IN A STRONG LONGITUDINAL MAGNETIC FIELD. V. M. Grigorovich and V. S. Mukhovatov (Akademiya Nauk S.S.S.R. Institut Atomnoi Energii). Translated by J. I. Pankove (Princeton Univ. Plasma Physics Lab., N. J.). 1963. 28p.

It was found that, for a given value of column displacement due to a force $1/c[IB_{\perp}]$, oscillations in the electrical characteristics of the discharge have a minimum amplitude and the average plasma conductivity becomes maximum. It is shown that the effect of a transverse component of the magnetic field can be explained in its main aspect by discarding the supposition of a plasma column at equilibrium inside a conducting skin. (auth)

**7795** (MATT-Trans-11) PROBE METHOD FOR MEASURING THE DISPLACEMENT OF A CURRENT COLUMN IN CYLINDRICAL AND TOROIDAL CAVITIES. S. V. Mirnov (Akademiya Nauk S.S.S.R. Institut Atomnoi Energii). Translated by J. I. Pankove (Princeton Univ. Plasma Physics Lab., N. J.). 1963. 33p. (Includes original, 20p.).

A method based on the differential connection of magnetic probes oriented along the field due to the current is proposed. In experiments performed on a machine with a toroidal discharge chamber, the initial position and the displacements during the discharge were determined with accuracies of 0.5 and 0.3 cm, respectively. The results obtained with the proposed method are compared with the results obtained by fast photography. (auth)

**7796** (MATT-Trans-12) STUDY OF OHMIC PLASMA HEATING IN THE TOROIDAL SYSTEM "TOKAMAK-3." L. A. Artsimovich, S. V. Mirnov, and V. S. Strelkov (Akademiya Nauk S.S.S.R. Institut Atomnoi Energii). Translated by J. I. Pankove (Princeton Univ., N. J.). 1963. 20p.

The first experiments on Tokamak-3 are described. It is shown that a correction of the magnetic field changes substantially the characteristics of the discharge. The motion of the column in the cavity was studied, and the relation between the displacements of the column and the regular oscillations in the oscillograms of electrical parameters was clarified. The dependence of plasma conductivity on the strength of the longitudinal field was determined. With a longitudinal field of 25000 oersteds, the conductivity is at least 1 to $2 \times 10^{16}$ CGSE. (auth)

**7797** A STUDY OF THE RADIO-FREQUENCY PROBE TECHNIQUE FOR PLASMA ELECTRON DENSITY MEASUREMENT. H. Gibson and M. J. Nicholls (English Electric Co. Ltd., Stafford, Eng.). Brit. J. Appl. Phys., 14: 870-6(Dec. 1963).

The radio-frequency probe technique is examined in order to determine the nature of the coupling between the probes, and the explanation of the multiple resonances that were observed. It is found that the coupling between the probes is best explained by assuming the coupling mechanism to be purely capacitative, rather than the induction field effect previously assumed. Multiple resonances were found that are associated with slow electromagnetic standing waves propagated along the length of the plasma. (auth)

**7798** THE MOTION OF CHARGED PARTICLES IN A MODEL DISCONTINUOUS MAGNETIC FIELD. S. Chapman and P. C. Kendall (Univ. of Alaska, College and Univ. of London). Bull. Inst. Politeh. Iasi, 8: No. 3-4, 81-92(1962).

The scattering of charged particles having small pitch angles in magnetic mirror fields is studied. It is shown that there is a slight focusing effect, i.e., that particles scattered are likely to emerge from the scattering interaction with a smaller pitch angle than they originally possessed. The implications of the results as regards the Van Allen belts and laboratory mirror machines are outlined. (T.F.H.)

**7799** PROBE CONTAMINATION IN A HYDROGEN PLASMA. A. G. Coulter and G. S. Higginson (Queen's Univ., Belfast). J. Electron. Control (1), 15: 437-45(Nov. 1963).

By making use of operational differentiation, the method of time differentiation was applied successfully to obtain second derivatives of Langmuir probe i-V characteristics in a hydrogen plasma. It is demonstrated that under certain conditions contamination of the probe by cathode material may result in an additional peak in the electron energy distribution. This is most pronounced when a well-defined group of fast electrons (>6 ev) is present and may be attributed to the ionization of barium in the vicinity of the probe surface. (auth)

**7800** CHARACTERISTIC EQUATION FOR DESCRIBING THE STABILITY OF A MAGNETO-IONIC PLASMA. Louis Gold (Kennecott Copper Corp., Lexington, Mass.). J. Electron. Control (1), 15: 447-8(Nov. 1963).

A characteristic equation that describes the behavior of the magneto-ionic plasma in a planar configuration is given. The electrostatic instabilities in the plasma were studied using the case of a planar diode with superposed longitudinal magnetic field. (R.E.U.)

**7801** THE EFFECT OF COULOMB COLLISIONS ON INCOHERENT SCATTERING OF RADIO WAVES BY A PLASMA. D. T. Farley, Jr. (Jicamarca Radar Observatory, Lima). J. Geophys. Res., 69: 197-200(Jan. 1, 1964).

The effect of Coulomb collisions on incoherent scattering and, in particular, on the gyroresonance phenomena, is investigated. It is shown that in many situations ion-ion interactions can completely destroy the resonance at the ion gyrofrequency even though the ion-ion collision frequency is much less than the ion gyrofrequency. The electron gyroresonance is also affected by the Coulomb collisions involving the electrons, but this effect is apt to be much less severe. (C.E.S.)

**7802** THE IMPORTANCE OF CONTAMINATION IN ARC INITIATION ON STAINLESS STEEL EXPOSED TO A TOROIDAL DISCHARGE. J. T. Maskrey and R. A. Dugdale (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 10: 233-42(Nov. 1963). (AERE-R-4282)

Arc initiation on a commercial stainless steel at room temperature exposed to a toroidal hydrogen discharge was investigated experimentally. The effect of impurity gases in the hydrogen and contamination on the surface of the steel were studied. The addition of oxygen or nitrogen to the torus gas has no effect. It was found that arc initiation is entirely due to both organic and inorganic contaminants on the cathode surface. Under the particular electrical conditions involved (1 kv, 8 Å/cm$^2$) inclusions in the steel are ineffective arc initiators when the contaminants have been removed by arcing, prolonged sputtering with argon ions, or vacuum heat treatment. The results are discussed in relation to previous work, including studies of the glow to arc transition process, and it is considered that the role of contamination could be connected with either field emis-

sion or with a vapor puff produced by electrical breakdown of insulating particles or films. (auth)

**7803** CHARACTERISTICS OF LANGMUIR PROBE IN A STRONG MAGNETIC FIELD. Kanehiro Nobata (Shizuoka Univ., Hamamatsu, Japan). Japan J. Appl. Phys., 2: 719-27(Nov. 1963).

The mechanism of the collection of charged particles by a Langmuir probe in a strong magnetic field is theoretically investigated. The magnetic field is assumed to be sufficiently strong, i.e., the electron cyclotron frequency exceeds the collision frequency of electrons with neutral gas molecules. When the length of the probe in the direction of the magnetic field is larger than the average gyration diameter of electrons, the probe current is determined by the gyration diameter, whereas when the probe length is smaller, the probe current is free from the effect of the magnetic field. Discussions are also given for the case where an electric field exists between the probe and the plasma. Experimental results concerned with the saturation electron current agree with the calculated values. (auth)

**7804** A NOTE ON WAVE PROPAGATION IN PLASMA. I. Fidone (Euratom-CEA, Fontenay-aux-Roses, France). Nuovo Cimento (10), 30: 666-71(Oct. 16, 1963).

An equation for the propagation of electromagnetic waves in a plane-layered inhomogeneous isotropic plasma is solved. The calculation is based on the dielectric method for treating the autocorrelation function of the fluctuating microfield in the plasma. (R.E.U.)

**7805** STRUCTURE OF PLASMA SHEATHS. Arrigo Sestero (New York Univ., New York). Phys. Fluids, 7: 44-51(Jan. 1964).

A model is given to provide a microscopic description of plasma sheaths, using the Vlasov equation for ions and electrons coupled with Maxwell's equations for the fields. The sheaths considered connect two different constant states of a plasma in a magnetic field. In the charge-neutral approximation a solution is obtained in closed form in terms of quadratures. The solution depends essentially on three free parameters, related to the differences in density and electric potential between the two end states, and to the value of $\beta$, the ratio of the plasma pressure to the magnetic pressure, on one side of the sheath. The scaling law changes considerably from one solution to another. Solutions are obtained that scale according to some representative electron Larmor radius, or ion Larmor radius, or piece-wise according to both. As a limiting case, when the density is allowed to go to zero on one side of the sheath, one obtains the boundary layer between a plasma and a containing vacuum magnetic field. As a peculiar feature in this limiting situation, the curve for the electric potential appears to be very sensitive to the slightest changes in the distribution functions, in the asymptotic region where the plasma density becomes vanishingly small. (auth)

**7806** GRAVITATIONAL RESISTIVE INSTABILITIES IN PLASMA WITH FINITE LARMOR RADIUS. J. D. Jukes (Culham Lab., Culham, Berks, Eng.). Phys. Fluids, 7: 52-8(Jan. 1964).

The linearized equations of a gravity driven, resistive instability of a plasma supported by a planar, sheared magnetic field are shown to be characterized by a variational principle from which an eigenvalue corresponding to a periodic growth is obtained. The effect of a finite ion Larmor radius is included through off-diagonal terms in the pressure tensor in the momentum fluid equation. When the Larmor radius is zero a numerical solution for the growth rate is found using a one parameter trial function that indicates that the correct function maximizes this rate. When the Larmor radius becomes significant, viz., with decreasing wavelength, the instability becomes an overstability with a reduced growth rate becoming proportional to the square root of the ratio of the resistivity to the wavelength. Whilst numerical results are given beyond this transition, the Larmor radius becomes comparable with the thickness of an internal resistive layer and the equations cease to be reliable. (auth)

**7807** EMISSION OF RADIO NOISE BY PLASMAS. T. J. M. Boyd (Univ. of Maryland, College Park). Phys. Fluids, 7: 59-63(Jan. 1964).

The generation of radio noise by plasma oscillations is studied by means of the collisionless Boltzmann equation for the electron component of the plasma. A second-order perturbation calculation is performed to determine the power spectrum for radiation at the second harmonic of the plasma frequency in a hot plasma in which there is no external magnetic field and the ions are of uniform density. (auth)

**7808** QUANTUM EFFECTS ON THE CONDUCTIVITY OF A DENSE PLASMA. S. Rand (Inst. for Defense Analyses, Washington, D. C.). Phys. Fluids, 7: 64-71(Jan. 1964).

The collective properties of a plasma, in its interaction with a radiation field, become important when the electron plasma frequency is comparable with, or exceeds, the radiation frequency. The particle interactions must properly be treated quantum mechanically when electron plasma wave phonon energies are of the order of, or greater than, average random electron energies. Both of these conditions may be satisfied for the system of optical or infrared radiation interacting with a dense plasma. Expressions for the high frequency conductivity and opacity are obtained for a dense, fully ionized plasma. It is found that, when the photon energy greatly exceeds the average random energy, and when the electron plasma frequency is much greater than the radiation frequency, then the free-free contribution to the opacity, ordinarily written without the inclusion of collective effects, is reduced by a factor of the order of $\overline{E}\Omega^3/\hbar\omega_p^4$, where $\overline{E}$ is the mean random electron energy in the plasma, $\Omega$ is the radiation angular frequency, $\hbar$ is Planck's constant, and $\omega_p$ is the electron plasma frequency. (auth)

**7809** RADIATION FROM A POINT SOURCE IN A PLASMA. Harold Weitzner (New York Univ., New York). Phys. Fluids, 7: 72-89(Jan. 1964).

The fundamental solution for the linearized relativistic Vlasov equation with Maxwell's equations is obtained. The unperturbed state is assumed to be spatially homogeneous and time independent, with no electric or magnetic fields. The unperturbed distribution function depends only on the magnitude of relativistic momentum. An examination of the asymptotic behavior of the electric field for large time permits a general description of the solution. The electric field may be expressed as the sum of transverse and longitudinal parts. The transverse part looks like an ordinary electromagnetic wave extremely close to the light cone, and within the light cone it oscillates rapidly with varying frequency and wave number and a local phase velocity greater than the speed of light. Near the origin of the disturbance there is a transition to an ordinary plasma oscillation. In addition to a weak precursor wave, the longitudinal wave propagates outward with a definite speed and behind its wavefront the electric field oscillates with

local phase velocity greater than the speed of light. Another ordinary plasma oscillation is left near the origin of the disturbance. The longitudinal speed of propagation goes to zero in the nonrelativistic case and to the speed of light in the extreme relativistic limit. The transverse and longitudinal fields defined according to the Fourier transform modes are not each zero outside the light cone, but their sum is zero. Thus, no signal travels faster than the speed of light. This peculiarity illustrates some unnatural aspects of the separation of a solution into modes of Fourier components. (auth)

**7810** PROPAGATION OF LONGITUDINAL WAVES IN A WEAKLY IONIZED GAS. G. M. Sessler (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Fluids, 7: 90-5(Jan. 1964).

The propagation of longitudinal waves in a weakly ionized gas consisting of three species of particles (neutrals, ions, and electrons) is analyzed giving full consideration to the influence of collisions between all three kinds of particles. The calculations are based on Euler's and Poisson's equations. Damping and phase constants for the neutral-particle wave, the ion wave, and the electron wave are presented for different values of particle densities and for frequencies lower than, or comparable to the plasma frequency of the ions. The main result of the calculations is that in a certain frequency range the damping of the ion wave can be smaller than the damping of the neutral-particle (sound) wave. This suggests the stimulation of ion waves by means of acoustic transmitters. Such an ion wave would be free of the potentially disturbing neutral-particle wave at some distance from the source. This method would make it possible to stimulate a purely longitudinal plane wave. (auth)

**7811** NATURAL OSCILLATIONS OF A BOUNDED PLASMA. Asim Yildiz and Paul A. Silberg (Raytheon Co., Wayland, Mass.). Phys. Fluids, 7: 96-102(Jan. 1964).

The general case of a compressible bounded electron plasma is examined. Linearized equations of motion are set up, boundary conditions are established, and the possible oscillations that could occur in the spherically bounded plasma are examined. Three different modes of oscillations are established; the plasma type of oscillations, the electric type of oscillations, and the magnetic type of oscillations. Dispersion relations for possible modes are obtained. (auth)

**7812** MICROWAVE–PLASMA INTERACTION IN A THERMALLY IONIZED PLASMA. Melvin Epstein (Aerospace Corp., El Segundo, Calif.). Phys. Fluids, 7: 121-9 (Jan. 1964).

Equations were formulated that govern the interaction between a plane transverse electromagnetic wave and the slightly ionized nonequilibrium gas flowing downstream of a shock wave. Under the assumption that the electromagnetic field is weak, the equations were linearized, and analytical solutions were obtained. These solutions indicate that significant localized heating of the gas can be accomplished only for narrow ranges of the parameters. Calculations were made for the increase in electron density and change in reflection coefficient. The results indicate that very small fields can heat the electrons enough to significantly alter the reflection coefficient. (auth)

**7813** MIXED SUSTAINED AND SELF-SUSTAINED DISCHARGE MECHANISM IN SHOCK-IONIZED ARGON. W. Daellenbach (Battelle Memorial Inst., Geneva). Phys. Fluids, 7: 138-41(Jan. 1964).

The electric discharge in dense plasmas such as those obtained in shock tube experiments is investigated theoretically. Assuming that the positive ion saturation current density is of the order of the positive ion random current density, it is shown that quite high current densities are possible in dense plasmas, without an electron emission at the cathode being required. For instance, current densities up to 1000 amp/cm$^2$ are possible in argon at a temperature of 15,000°K and a pressure of 1 atm. It is then shown that the positive ion mean free path is in general much larger than the positive space charge sheet near the cathode. Hence the positive ions may be accelerated by the cathode voltage drop. Since their accommodation coefficient is smaller than 1, they keep part of their kinetic energy after neutralization, and the additionally can heat up the plasma in the vicinity of the cathode. This self-sustained discharge mechanism, which represents a thermal breakdown of the plasma layer near the cathode, reduces the cathode voltage drop and limits the current density to a higher value. (auth)

**7814** COHERENT RADIATION BY PLASMA OSCILLATIONS. R. E. Skinner and J. Vollmer (Radio Corp. of America, Camden, N. J.). Phys. Fluids, 7: 148-50(Jan. 1964).

An input coupler was used to introduce an electromagnetic signal to an electron beam in a finite electron beam and a finite cesium plasma configuration. The signal was measured at the output coupler and at the microwave horn. There was no significant change in the signal level present at the output coupler when the plasma was introduced. The net transmitted gain ranged between –10 and +10 db. There was a significant change, at isolated frequencies, in the ratio of the radiated signal to the signal on the output coupler. It is proposed that the plasma is acting to couple longitudinal oscillations on the electron beam to electromagnetic waves. (C.E.S.)

**7815** PARTICLE CONFINEMENT AND POWER BALANCE IN THE MODEL C STELLARATOR. Wynford L. Harries, John O. Kessler, Rolf M. Sinclair, and Shoichi Yoshikawa (Princeton Univ., N. J.). Phys. Fluids, 7: 151-3(Jan. 1964). (MATT-205)

Mechanical equilibrium is achieved for a hydrogen plasma in a model C stellarator by adding to the toroidal magnetic field a component supplying rotational transform or, with a unidirectional current flowing in the plasma, by superimposing a magnetic field of appropriate magnitude perpendicular to the plane of the current. A power balance equation, valid during steady Ohmic heating conditions following complete ionization of the initial gas, is developed. (C.E.S.)

**7816** DRIFT OF A Θ PINCH IN A IOFFE MULTIPOLE FIELD. E. Hintz, A. C. Kolb, H. W. Lupton, and H. R. Griem (Naval Research Lab., Washington, D. C.). Phys. Fluids, 7: 153-4(Jan. 1964).

A compressed deuterium plasma in a Θ pinch with a long single-turn coil was observed to strike the wall in about 10 μsec after the start of the discharge. The drift toward the slot that feeds the current was caused by a magnetic field gradient. In order to reverse the gradients due to the slot, an Ioffe hexapole magnetic field was generated. The effect of this field on the drift was investigated, and it is shown that the location of the equilibrium position of the plasma can be estimated as a function of the magnetic field. (C.E.S.)

**7817** COULOMB INTERACTIONS IN A STRONG MAGNETIC FIELD. II. NONADIABATIC CASE. LINE PROFILE OF CYCLOTRON RADIATION. Robert Goldman

(Yale Univ., New Haven). Phys. Rev., 133: A647-61 (Feb. 3, 1964).

Using the generalized quantum treatment of pressure broadening by Anderson, an expression including the effects of both adiabatic and nonadiabatic transitions for the emission spectrum of cyclotron radiation from free charged particles undergoing Coulomb interactions with fixed scatterers in typical plasma situations is derived. After adapting the formalism to account for the continuous nature of the energy states parallel to the magnetic field, and after including the energy dependence of the dipole matrix element, one obtains half-width values for the cyclotron line in the case of a strong magnetic field. Extension to the weak field case can then be made in a plausible manner, resulting in the ordinary Coulomb cross section for vanishing magnetic field strength. (auth)

**7818** EFFECT OF COLLISIONS ON ELECTRON WAVES IN A PLASMA IN A MAGNETIC FIELD. Agnar Pytte and Ronald Blanken (Dartmouth Coll., Hanover, N. H.). Phys. Rev., 133: A668-72(Feb. 3, 1964).

The effects of electron-electron and electron-ion collisions on small oscillations in a fully ionized plasma imbedded in a constant external magnetic field are investigated. The first three moments are taken of the Boltzmann equation with the Bhatnagar-Gross-Krook collision terms. The low-temperature approximation is employed to close the set of equations. The moment equations and Maxwell's equations are solved simultaneously to obtain the dispersion relation for small amplitude electron waves propagating at an arbitrary angle to the external magnetic field. The dispersion relation, the collisional damping included, is studied in various limiting cases. The most striking collisional effect is the reduction and smoothing out of the resonance near the electron cyclotron frequency. (auth)

**7819** THEORY OF IRREVERSIBLE PROCESSES IN A PLASMA — DERIVATION OF A CONVERGENT KINETIC EQUATION FROM THE GENERALIZED MASTER EQUATION. Jerome Weinstock (National Bureau of Standards, Washington, D. C.). Phys. Rev., 133: A673-80(Feb. 3, 1964).

The theory of irreversible processes in plasmas is rigorously developed from the cluster formulation of the exact generalized Master equation. This equation is a time-dependent analog of the equilibrium virial expansion, and the development of the theory of nonequilibrium plasmas is found to parallel that of the well-known theory of equilibrium plasmas in a direct and simple way. A convergent kinetic equation for homogeneous plasmas is then derived which includes the effects of close collisions as well as long-range collisions and is exact to first order in the density — in the asymptotic limit of long times. The distinguishing feature of this kinetic equation is that it converges for the Coulomb potential. No arbitrary cutoffs or screened potentials are required to make it converge. The divergence of previous kinetic equations is directly attributed to the neglect of significant close collision terms (such equations are not exact to first order in the density). The method of derivation is quite general and the extension of the convergent kinetic equation to short times (non-Markoffian kinetic equation) as well as to general order in the density is indicated. (auth)

**7820** HIGH-FREQUENCY NOISE IN PROBES IMMERSED IN GAS DISCHARGES. A. R. Galbraith and A. Van der Ziel (Univ. of Minnesota, Minneapolis). Physica, 29: 1165-73(Nov. 1963).

Probes immersed in a gas discharge give noise with an equivalent saturated diode current $I_{eq} = (I_{eq0} + A\omega^{\alpha})$ and an a-c probe conductance $G_p = (G_{p0} + B\omega^{\alpha})$, where $\alpha \simeq 1.3$ for an unshielded probe in an unshielded tube and $\alpha \simeq 2$ for a shielded probe in a shielded tube. Since the high-frequency noise can be reduced by shielding, part but not all of the noise seems to come from the capacitive coupling between the probe and the plasma sheath at the glass wall. The values of A and B are only slightly dependent in the tube current. They are practically independent of probe current as long as part of the current is carried by electrons but both decrease for strongly negative probe bias. This makes it likely that the effect is mainly caused by electrons. The effect cannot be explained by electrons turning in front of the probe and inducing current pulses in the probe. (auth)

**7821** RADIATION DAMPING FOR SYSTEMS OF CHARGED PARTICLES IN A CONSTANT EXTERNAL MAGNETIC FIELD. F. Henin (Université Libre, Brussels). Physica, 29: 1197-1200(Nov. 1963).

The Liouville equation for relativistic charged particles derived previously is used to study the energy radiated away by systems of charged particles in a constant magnetic field. The calculations are restricted to the Born approximation. Part of the energy loss is due to the correlations between the particles. Some special cases (particles in a circular accelerator and nonrelativistic plasma with screened Coulomb interactions) are briefly discussed. (auth)

**7822** INCREASE OF PRESSURE IN THE CYLINDER-SYMMETRIC ELECTRIC ARC COLUMN IN SUPERIMPOSED MAGNETIC FIELDS. R. Wienecke (Institut für Plasmaphysik, Garching, Ger.). Z. Naturforsch., 18a: 1151-6 (Nov. 1963). (In German)

If an axial magnetic field is superimposed on a cylinder-symmetric electric arc column, the outward-directed diffusion flux of electrons and ions would be stopped at first, while the neutral particles would not at first be influenced. By this means the total pressure in the hot area increases. Proceeding from the impulse-preservation equation for the individual components, the dependence of the pressure pattern of hydrogen and helium on temperature under variation of the externally impressed magnetic field and of the gas pressure at the external boundary of the conductivity zone was calculated and discussed. The influence of the individual magnetic fields of the discharge on the pressure pattern was estimated on the basis of a model. (tr-auth)

**7823** EXCITATION OF ELECTRON-PLASMA OSCILLATIONS BY SHOCK WAVES. J. D. Welly (Technische Hochschule, Hanover). Z. Naturforsch., 18a: 1157-68 (Nov. 1963). (In German)

The velocity distribution of electrons within a plasma shock front was investigated by methods using the kinetic theory arranged in a manner to account for heavy deviations from thermodynamic equilibrium. The distribution function exhibits two peaks and becomes unstable with respect to electron oscillations if the shock wave is sufficiently strong (Mach number $M \gtrsim 6.5$). The second peak is formed by run-away electrons, i.e., those fast electrons which transgress the shock front from the hot region. The frequencies, wave numbers, growing rates, phase and group velocities of the excited oscillations, and the influence of the Ohmic damping were calculated approximately. The results were applied to the nonthermal radiofrequency radiation of the sun. (auth)

**7824** ELECTRODELESS THREE-COIL PLASMA GUN. W. Hertz, A. Koller, A. Michel, and H. Schindler (Siemens-

Schuckertwerke AG, Erlangen). Z. Naturforsch., 18a: 1237-8(Nov. 1963). (In German)

The electrodeless plasma gun is based on the principle of acceleration by the Lorentz force. Cusp-field geometry is used. Diagrams and optical studies are shown. (M.C.G.)

**7825** ELECTRON BEAM DIAGNOSTIC METHODS. Benjamin Patz and James Litton, Jr. (Martin Co., Baltimore). 6p. (CONF-284-6)

From National Electronics Conference on Adaptive Processes, Chicago, Oct. 1963.

The use of electron beams as probes in plasma diagnostics is over 50 years old. However, recent developments of this technique have yielded results that older techniques were unable to provide. This technique was used successfully in dark-space probing. Hollow Cathode Discharge probing, shock-wave diagnostics, and more recently, in diagnosing a novel form of beam mode discharge by use of the self-generated beam. Some of the desirable characteristics of beam probes are the relatively small perturbation of the plasma compared with a material probe, the ease with which beam deflection may be detected by simple photomultipliers and fluorescent screen, the freedom from work function changes and target contamination, and the independent control of beam velocity and current. Probes using small currents and high velocities can effectively be used in very dense plasmas. A survey of previously used beam probe techniques was carried out. Recent experiments using electron beam techniques are presented. (auth)

**7826** RECENT DEVELOPMENTS IN PLASMA GENERATION. T. B. Reed (Massachusetts Inst. of Tech., Cambridge). 7p. (CONF-284-5).

From National Electronics Conference on Adaptive Processes, Chicago, Oct. 1963.

A brief survey of the properties of thermal plasmas that determine methods of plasma generation is given. Recent developments in the generation of thermal and cold plasmas without electrodes using induction heating are discussed. The alteration of the behavior of the plasma in the vicinity of electrodes and the additional advantages and disadvantages that electrodes bring to plasma generation is covered. A number of new specific electrode plasma generation geometries are discussed, along with their pertinent applications. (auth)

**7827** CESIUM PLASMA TRANSPORT PROPERTIES. Plasma Laboratory Report No. 3. Bernard J. Eastlund (Columbia Univ., New York). 61p. (CONF-284-4)

From National Electronics Conference on Adaptive Processes, Chicago, Oct. 1963.

The transport properties of a cesium gas are computed for the temperature range of 350 to 10,000°K and for pressures of one atmosphere to $10^{-6}$ mm Hg. Values of electrical, thermal, and viscosity transport coefficients are determined. The thermoelectric coefficients are also determined. The Boltzmann two-body collision formulation for the transport properties is compared with the multicollision Fokker-Planck formulation and is shown to be equivalent. Hence, the extensively developed theory for gas mixture transport properties is employed using the Debye length as the cutoff in the collision integrals for Coulomb force interactions. Experimental data for cesium are used to find values for the collision integrals for ion-neutral and neutral-neutral interactions. Theoretical expressions are used for electron-neutral interactions and for interactions between charged particles. Limited experimental data compare well with the computed transport properties. (auth)

**7828** A MICROWAVE STUDY OF MOVING STRIATIONS USING CAVITY TECHNIQUES. S. F. Paik and K. D. Gilbert (Raytheon Co., Burlington, Mass.). 15p. (CONF-363-10)

From International Symposium on Plasma Phenomena, San Diego, Calif., Oct. 1963.

Variation of charge density in the positive column of a d-c discharge due to the presence of a moving striation is investigated. A microwave cavity operating in the $TM_{010}$ mode is used to measure the effects of the striation on the resonant frequency of the cavity. The results of the microwave measurements are compared with the photomultiplier data and the probe characteristics. Although no quantitatively accurate data could be obtained from the microwave measurement, some interesting results that contradict qualitatively previous observations of the striation are presented. (auth)

**7829** THE MAGNETO GAS DYNAMIC ANALOGUE OF ČERENKOV RADIATION. [PART] II. A. Cantor and J. Farber (Sylvania Electronics Systems, Waltham, Mass.). 25p. (CONF-363-9)

From International Symposium on Plasma Phenomena, San Diego, Calif., Oct. 1963.

The problem of the extra-low-frequency radiation produced by a single charged particle traveling along the lines of force of a constant external magnetic field embedded in an infinite, highly anisotropic plasma, is considered. The problem resembles, to some extent, the ordinary Cherenkov problem in which charged particles, by a collective mechanism, generate visible radiation when passing through transparent substances. The ELF analogue — which is called the magneto gas dynamic analogue of Cherenkov radiation — has several distinguishing features. For one, the radiation is most important in a narrow cone of angles centered on the magnetic field line of the source. In addition, the magnetic field of the wave is transverse but the electric field is longitudinal. The disturbance is thus not circularly polarized as these are not transverse waves. Also, in addition to the usual Cherenkov component, for which the particle velocity must be greater than $\underline{a}$ (the Alfven phase velocity), there exists a weaker component originating from particles of velocity less than $\underline{a}$. (auth)

**7830** MAGNETIC FIELD ANNIHILATION. H. E. Petschek (AVCO Corp., Everett, Mass.). 33p. (CONF-246-1)

From Solar Flare Symposium, Greenbelt, Md., Oct. 1963.

Sweet's mechanism for the rate of annihilation of magnetic field at the boundary between two regions of plasma containing oppositely directed field lines is re-examined. It is pointed out that previous analyses overlooked standing magnetohydrodynamic waves as a possible mechanism for converting magnetic energy to plasma energy. An estimate of the annihilation rate including such waves is made. Using this rate it is found that the energy required for a flare can be released in $10^2$ sec. This time is short enough to account for the observed solar flare times if the source of the flare energy is stored magnetic energy. (auth)

**7831** PROPAGATION AND INSTABILITIES IN PLASMAS. SEVENTH LOCKHEED SYMPOSIUM ON MAGNETOHYDRODYNAMICS, [DECEMBER 14-15, 1962, PALO ALTO,

CALIFORNIA]. Walter I. Futterman, ed. Stanford, California, Stanford University Press, 1963. 149p. $4.50.

Both review material and new results and viewpoints are presented in the 9 papers given. The articles range over three aspects of the plasma medium; the propagating wave modes it will support, some characteristic instabilities, and propagation by transport. Two of the papers were previously abstracted for NSA. (R.E.U.)

*For abstracts of individual papers see: 7832, 7833, 7834, 7835, 7836, 7837, and 7838.*

**7832** WAVES IN UNIFORM, MAGNETOACTIVE PLASMAS. S. J. Buchsbaum (Bell Telephone Labs., Inc., Murray Hill, N. J.). p.1-24 of "Propagation and Instabilities in Plasmas." Stanford, California, Stanford University Press, 1963.

The various postulations of existence of waves in plasmas are presented. An attempt was made to classify the various waves and their properties in some systematic manner without limitation on the range of the plasma and wave parameters (density, magnetic field, and frequency), which govern the characteristics of the propagation vector of the wave. A so-called $(\alpha^2,\beta^2)$ plane is introduced and waves are classified according to polarization. The main assumptions underlying the basic physical models used are discussed. (R.E.U.)

**7833** WHISTLERS. R. A. Helliwell (Stanford Univ., Calif.). p.25-36 of "Propagation and Instabilities in Plasmas." Stanford, California, Stanford University Press, 1963.

Electromagnetic propagation below the plasma and electron gyro-frequency in ionospheric plasmas is discussed. Dispersive effects, ray paths, wave-packet velocities, duct propagation, waveguide coupling, and absorption in whistler-mode propagation are discussed. Man-made whistler-mode signals and whistler-triggered emissions are also discussed. (R.E.U.)

**7834** THE QUASI-LINEAR THEORY OF PLASMA OSCILLATIONS AND INSTABILITIES. Stephen E. Bodner and Edward A. Frieman (Princeton Univ., N. J.). p.37-51 of "Propagation and Instabilities in Plasmas." Stanford, California, Stanford University Press, 1963.

The linearized theory of plasma oscillations was studied to determine the nature of unstable oscillations. The linearized equations keep the spatially averaged distribution function time-dependent and determine the growth rate of the unstable waves. The linearized theory breaks down after a few e-folding times because of the effect on the distribution function. In the quasilinear theory the particle-wave interactions are considered dominant. Two coupled equations are obtained; first for the time rate of change of the spatially averaged distribution function and second, the time rate of change of the spectral energy density. (R.E.U.)

**7835** SOME ASPECTS OF THEORETICAL PLASMA PHYSICS IN THE UNITED KINGDOM. George Rowlands (United Kingdom Atomic Energy Authority, Abingdon, Berks, Eng.). p.52-69 of "Propagation and Instabilities in Plasmas." Stanford, California, Stanford University Press, 1963.

Some of the work in theoretical plasma physics in the United Kingdom is discussed. Included are computer programs for solving MHD equations for plasma behavior, transverse-wave instabilities using the linearized Vlasov equation, finite Larmor-radius stabilization, and hydromagnetic waves in a cold plasma. Diagnostic methods of experimental plasma physics are also discussed. (R.E.U.)

**7836** ENERGY TRANSFER IN A DENSE PLASMA. James A. Fay (Massachusetts Inst. of Tech., Cambridge). p.103-14 of "Propagation and Instabilities in Plasmas." Stanford, California, Stanford University Press, 1963.

In assessing the relative roles of diffusion of heat and recombination energy in a collision-dominated plasma, it is found that the former is augmented by the presence of electrons whereas the latter is inhibited by charge-exchange collisions. Also, the former can be reduced by magnetic fields whereas the latter is relatively unaffected. Under the proper conditions of electron density and temperature, the energy transport due to photons may be treated as a conduction process and may be the dominant energy-transport mechanism. The boundary-layer concept is used as a basis of the energy-transfer discussion. The relative effects of diffusion of heat by particle collision and by radiation and the effects of diffusion of ionized particles to a cold wall are assessed. (auth)

**7837** OPTIMIZATION OF FLOWING-PLASMA AND EXTERNAL-CIRCUIT INTERACTION. M. G. Haines (Imperial Coll. of Science and Tech., London) and W. B. Thompson. p.115-23 of "Propagation and Instabilities in Plasmas." Stanford, California, Stanford University Press, 1963.

The one-dimensional electromagnetic channel-flow problem was studied taking into account the modification of the applied magnetic field by the current between the electrodes. An exact integration of the set of equations is obtained. The circuit parameters and magnetic field are optimized so as to obtain the greatest efficiency of interaction for the supersonic power-generation mode of operation. (R.E.U.)

**7838** EXPERIMENTS ON THE UPSTREAM WAKE IN MAGNETO-FLUID DYNAMICS. Harlow G. Ahlstrom (Univ. of Washington, Seattle). p.124-44 of "Propagation and Instabilities in Plasmas." Stanford, California, Stanford University Press, 1963.

Experiments were performed on a semi-infinite Rankine body in a uniform magnetic field, which is parallel to the direction of motion. The magnetic field perturbations forward of the body were measured. As a result of these measurements, it is shown that the magnetic Reynolds number determines the order of magnitude of the disturbance. A wake upstream of the body was observed, and its effects were determined by the magnetic Oseen number. It is shown that the disagreement between the infinite fluid theories and the experiments is due to the wall effects, and by a simple theoretical approach, results were found that give an estimate of the ranges of the parameters in which the wall effects should be important. (auth)

## Shielding

**7839** (NP-13434) DIFFERENTIAL DOSE ALBEDO MEASUREMENTS FOR 0.66-Mev γ's INCIDENT ON CONCRETE, IRON AND LEAD. Report No. 412. C. E. Clifford (Canada. Defence Research Chemical Labs., Ottawa). Aug. 1963. 25p.

The angular dependence of the scattered dose produced by 0.66-Mev gamma rays incident on concrete, Fe, and Pb was measured for angles of incidence of 0, 30, and 60°. A Monte Carlo program was used to study the distribution of distances between the point of incidence and the point at which a backscattered gamma ray emerged as well as the depth of the point at which a backscattered gamma ray had its last scattering interaction. The effect of the thickness

of the scatterer on the angular distribution of the scattered dose was measured for Fe exposed at normal incidence. The angular distributions of the scattered radiation from the three materials studied were found to be dependent both on the angle of incidence and on the angle of scatter to a detector and could not be related to each other by simple multiplicative factors. As the angle of incidence increased the scattering in the forward directions became increasingly anisotropic. (auth)

**7840** (ORNL-3499(Vol.II)(p.3-7)) CALCULATIONS OF THE THREE-DIMENSIONAL DEVELOPMENT OF HIGH-ENERGY ELECTRON-PHOTON CASCADE SHOWERS. C. D. Zerby and H. S. Moran (Oak Ridge National Lab., Tenn.).

Results from the IBM-7090 Monte Carlo calculations of electron-photon cascades for particle energies up to 50 Bev are compared with experiments. Fair agreement is shown with preliminary results from a Stanford experiment in which the energy deposited in copper by a shower initiated by 950-Mev electrons was determined. Reasonably good agreement is also shown with results of an experiment in which electron beams of 100, 200, and 380 Mev were directed into a bubble chamber and the number of charged particles (E > 1 Mev) that passed through a lead slab in the chamber was determined. (auth)

**7841** (ORNL-3499(Vol.II)(p.9-11)) CALCULATION OF ENERGY DEPOSITED IN WATER, ALUMINUM, AND COPPER BY A 20-Gev ELECTRON BEAM. C. D. Zerby and H. S. Moran (Oak Ridge National Lab., Tenn.).

The energy deposition by a narrow 20-Bev electron beam in $H_2O$, Al, and Cu (materials being considered for the beam stopper for the Stanford accelerator) was calculated. In the case of $H_2O$, a rough calculation using the energy deposition data indicates that it would take approximately 11 sec to completely vaporize the $H_2O$ if it were not circulated. Hydrogen and oxygen dissociation would also be significant. (auth)

**7842** (ORNL-3499(Vol.II)(p.12-13)) CALCULATION OF ENERGY DEPOSITED IN SHIELDED SOLAR CELLS BY HIGH-ENERGY ELECTRONS. C. D. Zerby and H. S. Moran (Oak Ridge National Lab., Tenn.).

The energy deposited by 3- and 6-Mev electrons incident on a 0.04064-cm thick solar cell with aluminum shields of various thicknesses was calculated. Discrepancies between the calculated results for the 3-Mev case and experimental results obtained for a 3.51-Mev incident energy are probably due to inaccuracies in the calculation at low energies and to the difference in incident energies. (auth)

**7843** (ORNL-3499(Vol.II)(p.14-22)) PRELIMINARY RESULTS FROM NUCLEAR EMULSIONS EMBEDDED IN A STEEL SHIELD EXPOSED TO A NARROW 9-Gev/c PROTON BEAM. R. L. Childers (Oak Ridge National Lab., Tenn.).

The emulsions were placed both along the axis of the nuclear cascade and at various distances off the axis. The results of track intensity measurements indicate an attenuation length of 133 ± 8 g/cm$^2$ along the shower axis. The lateral distributions of shower-track intensity and the star density along the beam are presented. (auth)

**7844** (ORNL-3499(Vol.II)(p.25-6)) SPACE VEHICLE SHIELDING STUDIES: THE ATTENUATION OF SOLAR FLARES BY ALUMINUM SHIELDS. R. G. Alsmiller, Jr. and J. E. Murphy (Oak Ridge Gaseous Diffusion Plant, Tenn.).

Nucleon-meson cascade calculations were performed with the straightahead approximation for several solar flare proton spectra incident on shields with approximately the properties of aluminum and with spherical-shell and slab geometries. (auth)

**7845** (ORNL-3499(Vol.II)(p.27-30)) INTRANUCLEAR CASCADE CALCULATIONS FOR INCIDENT PARTICLE ENERGIES FROM 25 TO 359 Mev AND FROM 25 Mev TO 2 Gev. H. W. Bertini (Oak Ridge National Lab., Tenn.).

The program for calculating the reactions of 25- to 350-Mev particles with complex nuclei was put into production, and debugging of the program for reactions at energies up to 2 Bev was undertaken. The type of information available from the calculations up to 350 Mev and modifications required for higher-energy calculations are discussed. (auth)

**7846** (ORNL-RSIC-2) CUMULATIVE BIBLIOGRAPHY OF LITERATURE EXAMINED BY THE RADIATION SHIELDING INFORMATION CENTER. S. K. Penny, D. K. Trubey, L. Jung, and M. B. Emmett (Oak Ridge National Lab., Tenn.). Sept. 1963. Contract W-7405-eng-26. 312p.

This bibliography supersedes the first bibliography (ORNL-RSIC-1). The references are arranged in nine major subject categories: general, basic nuclear and atomic information, radiation effects, transport theory, experimental techniques, radiation transport calculations and experiments for simple geometries, shield design techniques, calculations and experiments for complex systems, and shielding materials. An author index is included. (D.L.C.)

**7847** (USNRDL-TR-677) GEOMETRY AND BARRIER ATTENUATION GENERATED BY A VERTICAL SLAB EXPOSED TO A PLANE $Co^{60}$ SOURCE. G. E. Plummer and W. G. Miller (Naval Radiological Defense Lab., San Francisco). Sept. 27, 1963. 50p. (AD-424495)

A solution to the problem of determining the dose received by a detector with a vertical barrier interposed between it and a horizontal infinite radiation field was attempted. Steel barriers of effective mass thickness 0 to 73 lb/ft$^2$ were employed. The detector was collimated so that regardless of its distance from the barrier it always saw a constant circular area on the barrier. The infinite radiation field was simulated by a traveling $Co^{60}$ source that was pumped through an array of plastic tubing that covered a 100-ft semicircular area. An extrapolation to the infinite field case was attempted. The final results are expressed as ratios of dose received by a collimated, shielded detector relative to the free-in-air dose received by an unprotected detector 3 ft above the plane. The experimental points are compared to theoretical curves. (auth)

**7848** (USNRDL-TR-681) THE EFFECT OF SOURCE DISTANCE ON BUILDUP FACTOR FOR GAMMA RAYS PENETRATING INTO A COMPARTMENTED STRUCTURE. S. Tomoeda, A. L. Frank, and M. B. Hastings (Naval Radiological Defense Lab., San Francisco). Oct. 8, 1963. 44p.

In order to correlate some basic measurements of radiation attenuation made on an aircraft carrier to other situations and geometries, experiments were performed to study the effects of source distance on the dose distribution inside a model-sized compartmented structure intended to simulate the carrier. Data are presented in the form of buildup factors ($B_\epsilon$) as a function of source-to-detector distance for two configurations of the compartmented structure. Buildup factors are also presented as a function of the slant path through the interposing steel plates for the case where the source is considered far from the structure. Comparisons of the buildup factors

within the complex structure with the more basic single-slab dose-buildup factors obtained by other investigators are also presented. In every case, the buildup factor for the compartmented structure was found to be consistently and significantly lower than the single-slab data. The greatest differences in buildup ($B_r$-1) amounted to 30%. (auth)

**7849** THERMAL NEUTRON DIFFUSION MEASUREMENTS IN CONCRETE BY THE PULSED SOURCE METHOD. W. J. Paterson, E. W. Etherington, and R. Berenbaum (United Power Co., Heston, Middx., Eng.). Brit. J. Appl. Phys., 14: 912-15(Dec. 1963).

The diffusion lengths, diffusion coefficients, and macroscopic absorption cross sections for thermal neutrons in various concretes were determined using the pulsed-source method. The transport cross section for the hydrogen in the bound water of the concrete was also determined and is found to decrease with increasing combined water content. It is therefore not possible to select any single value of this cross section for use in neutron shielding calculations. (auth)

**7850** RADIATION SHIELDING PLASTIC CLAD. Henry F. Peters (to Lukens Steel Co.). U. S. Patent 3,114,839. Dec. 17, 1963. Filed May 25, 1959.

A shielding material composed of a metallic layer and one or more plastic layers bonded together is patented. The plastic layers contain evenly dispersed fines of different shielding characteristics. The fines of one plastic layer may be rice hulls, peanut hulls, or soybean hulls, and those in the other layer may be oxides of In, B, or Cd. One of the plastic layers is composed of relatively soft material, and the other of relatively hard material. The shielding material may be made by dipping the metal plate into a solution of plastic or by other known methods, and it may be fabricated into different shapes. (M.P.G.)

# REACTOR TECHNOLOGY

## General

*Refer also to abstract 6923.*

**7851** (AED-C-09-03) AUSGEWAHLTES SCHRIFTTUM NACH SACHGEBIETEN. MESS- UND REGELTECHNIK AN KERNREAKTOREN. BIBLIOGRAPHISCHE ZUSAMMENSTELLUNG. (Selected Literature According to Subject Field. Measurement and Control Techniques in Nuclear Reactors. Bibliographic Compilation). D. Gessmann, comp. (Hartmann & Braun, A. G., Frankfurt am Main). Nov. 1963. 52p.

One hundred and eighty-one references on measurement and control techniques in nuclear reactors are presented. The period covered is Jan. 1 to Dec. 31, 1962. The references are arranged by subject and report number and author indexes are included. (M.C.G.)

**7852** (HW-66666(Rev.2)) REVIEW OF POWER AND HEAT REACTOR DESIGNS. Domestic and Foreign. E. R. Appleby, comp. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1963. Contract AT(45-1)-1350. 279p.

Unclassified information from domestic and foreign literature from January 1952 through September 1963 is compiled. Design characteristics and current information on the status of the individual designs are given, along with references for the associated literature. SNAP systems, proposed reactors, and chemonuclear and test reactors with characteristics similar to power reactors are included. The designs are indexed by name, location, type, and some special characteristics. (D.C.W.)

**7853** (KR-58) QUARTERLY PROGRESS REPORT, APRIL–JUNE 1963 [ON IFA ACTIVITIES]. (Norway. Institutt for Atomenergi, Kjeller). 56p.

Reactor operations, instrument development, physics measurements and calculations, and component development for Norwegian programs are summarized. (T.F.H.)

**7854** (RT/ING(63)-27) BIBLIOGRAPHY ON ORGANIC REACTOR TECHNOLOGY FROM JANUARY 1947 THROUGH JUNE 1962. G. C. Pinchera, S. Piermattei, and R. Di Menza (Italy. Comitato Nazionale Energia Nucleare, Rome). Nov. 1963. 136p.

The bibliography of 889 references covers the literature published on the subject of organic-cooled reactors. The material is arranged under the following subject headings: General, Organic Liquid Technology, Fuels and Materials, Heat Transfer and Fluid Flow, Mechanical Components, Instrumentation and Control, Reactor Physics, Reactors, and Safety. Author and corporate author indexes are included. (auth)

**7855** UNCERTAINTIES IN FAST POWER REACTOR DOPPLER COEFFICIENTS AND THEIR EFFECTS ON ECONOMICS. A. V. Campise and D. J. Stoker. 24p. (CONF-334-13)

From Conference on Breeding Economics, and Safety in Large Fast Power Reactors, Argonne, Ill., Oct. 1963.

The economic influence of using the Doppler coefficient as a design criterion, because of the uncertainty in its prediction, is discussed. The importance and theory of calculation of Doppler coefficients and the characteristics of economically operated cores and fuel cycles for fast sodium-cooled reactor systems are discussed. (R.E.U.)

**7856** COMPARISON OF THE DYNAMIC AND SAFETY CHARACTERISTICS OF FAST AND FAST-COUPLED REACTOR SYSTEMS. Anthony V. Campise. 20p. (CONF-134-12)

From Conference on Breeding Economics, and Safety in Large Fast Power Reactors, Argonne, Ill., Oct. 1963.

A general integral theory and approximations for fast-coupled reactor systems are presented. Hypothetical discussions on safety and maximum credible accidents for sodium-thermal, -fast, and -fast-coupled reactor cores are presented. (R.E.U.)

**7857** NUCLEAR REACTOR COOLED AND MODERATED BY AN ORGANIC LIQUID. (to United Kingdom Atomic Energy Authority). French Patent 1,295,655. May 2, 1962. Priority date June 14, 1960, Great Britain.

A nuclear reactor comprises a pressure vessel of general cylindrical shape, a reactor core disposed in a lower region of this vessel enclosed laterally and at its bottom by a shielding structure, a heat exchanger placed within an annular region of the vessel between the vessel wall, and a cylindrical wall forming an extension of the lateral shielding structure. The pressure vessel is filled with an organic liquid serving as a coolant and as a moderator. A pump is provided for circulating this liquid from the bottom of the vessel through the core and the cylindrical wall to the vessel top and from there on downward through the heat exchanger. The shielding of this structure and the bulk shielding due to the organic liquid are sufficient to ensure that the activity at the outer surface of the pressure vessel is low enough to avoid the necessity of a shielding. Preferably the shielding structure comprises layers of neutron-absorbing material forming between the interspaces through which organic liquid circulates. (IIB)

## Auxiliaries and Components

**7858** (AEEW-R-144) THE EFFECTIVE NEUTRON TEMPERATURE IN HEATED GRAPHITE SLEEVES. J. A. Shaw and V. G. Small (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Aug. 1963. 20p.

In a series of oscillator measurements carried out in the reactor NERO the variation of the relative reaction rates of cadmium and boron absorbers was used to determine the effective neutron temperature inside heated graphite sleeves. This work extends the scope of similar oscillator measurements previously carried out in DIMPLE, in that the bulk moderator is now graphite as, opposed to $D_2O$ in the former case. (auth)

**7859** (GNEC-318) HYDRAULIC BALL (HY-BALL) CONTROL SYSTEM DEVELOPMENT PROGRAM. Sixth Quarterly Progress Report, October–December 1963. (General Nuclear Engineering Corp., Dunedin, Fla.). Contract AT(38-1)-207. 83p.

A physics analysis, including void-distribution and burnup effects, of the axial power distribution of a core with an axial zone of distributed poison was completed. A physics analysis of the axial power distribution of a core with three axial zones of different enrichment fuels was partially completed. Calculations were performed to indicate the shutdown effectiveness of the fast scram of a single Hy-Ball column (per fuel assembly) versus a slower scram of

all five Hy-Ball columns (per fuel assembly). Tests were run with room temperature water on pusher-buffers to find a configuration with maximum hydraulic drag for a given operating clearance with respect to the Hy-Ball column tube. After lift and scram tests and additional modifications to reduce peak deceleration rates, labyrinth type pusher-buffers were installed in the hot test loop Hy-Ball column assemblies for reactor temperature Test No. 3-c. Room temperature water leakage tests were run to check the performance of the three-way control valve GNEC-1 after a total of 175,000 cycles of satisfactory operation with reactor temperature water. Two configurations of piston piston-ring assemblies were leak tested with room temperature water. The reactor temperature tests, designated No. 2-c, which consisted of cycling the Hy-Ball columns and control value systems were completed. The flow-control buffer system was used for this series of tests. The reactor temperature Test No. 3-c is a cycling test (lift and scram) with labyrinth pusher-buffers installed in the fast scram columns. At this time, both the ball- and cylinder-loaded Hy-Ball column assemblies have operated for approximately 26,500 cycles. (auth)

**7860** (HW-77954(p.6.20-6)) N-REACTOR PRESSURE TUBES. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Stress-rupture tests were performed on specimens of two different types of Zircaloy-2 pressure tubing in both the autoclaved and unautoclaved condition. In both instances performance of the unautoclaved material was greatly inferior. It was concluded that the autoclave treatment produces some sort of aging phenomenon. Four types of Zircaloy-2 pressure tube material ranging from 30 to 65% cold work were tested for susceptibility to brittle fracture by introducing a defect into a test specimen under given conditions of temperature and pressure. Results varied from brittle for the 65% cold-worked material to tough for the 30%. The latter material typical of the tubes installed in the NPR shows a fracture toughness nearly equivalent to that of the steels used in turbine rotors. Project CAH 922 is for the construction of a facility in which irradiated sections of reactor process tubing will be evaluated in order to determine the effect of radiation and service on the mechanical properties of the materials. The project is estimated to be 28% complete versus a scheduled 30%. Completion is scheduled for February 1964. An ultrasonic wall thickness measuring device is being developed to measure the wall thickness on irradiated materials before, during, and/or after rupture testing. A prototype high temperature furnace is being developed in which tubular test sections can be evaluated at temperatures to 1800°F (982°C). One test was conducted at a temperature of 1750°F (954°C). (auth)

**7861** (ORNL-TM-738) OPERATING EXPERIENCE WITH COINCIDENT VS. NONCOINCIDENT REACTOR SAFETY SYSTEMS. E. P. Epler (Oak Ridge National Lab., Tenn.). Dec. 12, 1963. Contract W-7405-eng-26. 6p.

A study of reactor operation shows that systems employing coincidence have experienced more scrams resulting from instrument malfunction than those systems not employing coincidence. Although it is demonstrated that coincidence is not the dominant factor in safety system serviceability, it is planned to employ coincidence at ORNL in order to permit on-line testing of new, more complex safety systems. (auth)

**7862** (RT/EL(63)-10) AMPLIFICATORI DI PERIODO E DI ERRORE PER CONTROLLO AUTOMATICO DI IMPIANTI NUCLEARI. (Period and Error Amplifiers for the Automatic Control of Nuclear Plants). F. Conti, M. Conti, and A. Garroni (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratorio Ingegneria e Servomeccanismi Reattori, Ispra). July 1963. 27p.

Devices for controlling the flux of a reactor over six decades ($10^{-10}$ to $10^{-4}$ A) and, in connection with other devices, the temperature and power are described. The error amplifier has a logarithmic characteristic and covers the range $10^{-10}$ to $10^{-4}$ A with 1% precision. (auth)

**7863** (RT/EL(63)-13) UN AMPLIFICATORE DI SICUREZZA PER REATTORI NUCLEARI. (A Safety Amplifier for Nuclear Reactors). M. Conti and A. Garroni (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). June 1963. 22p.

A solid state safety amplifier that provides a continuous adjustable trip level between $10^{-8}$ and $10^{-4}$ A is described. On the high voltage for the ionization chamber is superimposed a 15Kc check signal, and a trip occurs also if only one failure occurs in the whole channel (HV off, cables disconnected, amplifier damage). Therefore, the whole channel is fail-safe. (auth)

**7864** (RT/FIMA(63)-2) EFFICIENZA DI BARRE DI CONTROLLO CON I METODI SUPERCELLA E NORDHEIM-SCALETTAR. (Effectiveness of Control Rod by Multicell and Nordheim-Scalettar Methods). M. Motta (Italy. Comitato Nazionale per l'Energia Nucleare, Bologna). June 1963. 47p.

A FORTRAN program that calculates control rod effectiveness in a cylindrical reactor is described. The worths of slab, cruciform, and cylindrical control rods are obtained for different thicknesses to give a parametric output. The results obtained for cylindrical rods with the multicell method and the Nordheim-Scalettar method are compared. (auth)

**7865** (TID-19871) STUDIES OF REACTOR CONTAINMENT STRUCTURES. Bi-monthly Progress Report No. 8262-7. R. L. Chiapetta, C. J. Costantino, P. G. Hodge, S. A. Morse, and M. A. Salmon (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Oct. 1963. Contract AT(11-1)-578. 176p.

The development and design of reactor containment structures are studied. Information is given on: dynamic response of cylindrical shells with either rigid or hemispherical end closures, results of a simplified analysis of the effects of shielding on dynamic response, results of experiments on pressurized cylinders of finite length, static and dynamic response of a spherical membrane cap with a reinforced circular opening, yield loads for thin spherical shells with small reinforced circular holes, reinforcement of a circular cylindrical membrane shell with a circular cutout, full strength reinforcement of a cutout-cylindrical shell, bulging experiments, development of containment handbook, and material evaluation. (N.W.R.)

**7866** (AERE-Trans-969) MAGNETIC-MEMORY PERIOD METER. R. Bolliet (France. Commissariat a l'Energie Atomique, Paris). Translated by R. R. Inston (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.), from report DPE-SPE-63/99/831. 1963. 26p.

An apparatus for measuring the doubling time T, where the neutron flux increases as $\phi = \phi_0 \times e^{0.693t/T}$, with continuous readout is described. It also operates in the more unusual case of convergence measurements. The principle of a magnetic-tape recorder is used, permitting compari-

son of two different values of the divergent flux in a servomechanism computer. (D.C.W.)

**7867** AN IN-CORE FAILED FUEL LOCATION AND MONITORING SYSTEM FOR BOILING WATER REACTORS. R. N. Osborne (General Electric Co., Pleasanton, Calif.). 8p. (CONF-243-39)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

An in-core failed fuel location system is described. This equipment makes it possible to obtain data on the fission gas release and rates of propagation from individual fuel elements. An even more valuable application lies in its use for location of defective fuel elements in power reactors, for the system not only identifies failed fuel during power operation, but distinguishes those elements that have progressive or excessive failure from those with low and constant release rates. (auth)

**7868** IMPROVED EMERGENCY SHUTDOWN FOR NUCLEAR REACTORS. (to General Dynamics Corp.). British Patent 944,194. Dec. 11, 1963. Priority date Aug. 2, 1961, United States.

An emergency shutdown apparatus for a reactor comprises a control rod and a suspension means disposed above the reactor core. The suspension means includes a temperature-responsive substance by which the control rod is attached to the suspension means; the substance has an appreciable structural strength at normal ambient reactor temperatures but virtually no strength at abnormal reactor temperatures, causing the control rod to fall into the core. Several embodiments of the shutdown apparatus are described. (D.L.C.)

**7869** DEVICE FOR INDICATING THE ELEMENTS OF A LATTICE. Roland Cochinal and Rene Donguy (to Commissariat a l'Energie Atomique). British Patent 944,453. Dec. 11, 1963. Priority date Dec. 30, 1960, France.

A device for automatically indicating an anomaly or defect occurring at any point in a reactor lattice is designed for use in conjunction with a slug burst detection system. The device comprises a register of addresses of the elements to be indicated on several disks of transparent material, a rotary shaft fast with the disks, a driving motor for rotating the disks, and a screen with an opening placed against the disks so that all but the indicated reference numbers are covered. (D.L.C.)

**7870** IMPROVEMENTS IN OR RELATING TO NEUTRON SHIELDS FOR NUCLEAR REACTORS. Thomas Standen, Laurence Hack, and Ronald Hugh Campbell (to United Kingdom Atomic Energy Authority). British Patent 944,803. Dec. 18, 1963. Filed Mar. 11, 1960.

A control rod is designed with neutron shielding so that neutron streaming through control rod access passages in the shielding is prevented. The shielding is disposed in the end of the control rod which is remote from the moderator when the rod is withdrawn. (D.L.C.)

**7871** IMPROVEMENTS IN MONITORING DEVICES FOR DETECTING FISSION PRODUCTS IN A GASEOUS STREAM. Jean Graftieaux and Rene Donguy (to Commissariat a l'Energie Atomique). British Patent 945,304. Dec. 23, 1963. Priority date May 19, 1959, France.

A device of the decay chamber–collecting drum–counting detector type is designed for detecting short-lived fission products and thus fuel can bursts in gas-cooled reactors. The device is generally the same as that described in British Patent 923,083, but is modified in the following ways: the drum is housed in a cavity of a metallic casing where it fits closely and is rotated about its axis by a magnetic coupling mechanism, and the gas conduit is separated from the rest of the device. Thus, the volume of unused gas surrounding the drum is minimized and the driving mechanism is protected from radioactive gas and is more accessible. (D.L.C.)

**7872** IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Escher Wyss AG). British Patent 946,023. Jan. 8, 1964. Priority date Sept. 7, 1959, Switzerland.

A device was designed for shutting down automatically a fluid-cooled reactor in the event of overheating of the reactor. The apparatus consists of a containing vessel for neutron-absorbent gas arranged in the outlet space of the coolant flow path and provided with at least one pipe opening into the inlet space of the coolant flow path. The mouth of the pipe has a pressure-responsive closure member arranged, in operation, to open automatically when a predetermined gas pressure in the vessel is exceeded so that neutron-absorbent gas is admitted to the reactor. (M.C.G.)

**7873** IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. Thomas Basil Webb (to Babcock and Wilcox Ltd.). British Patent 946,114. Jan. 8, 1964. Filed June 15, 1960.

A pressure-tube reactor was designed with tube walls of low-neutron-capture-cross-section materials enclose coolant channels within the reactor core and connect to inlet and outlet headers. The headers are of steel and the connection of a pressure tube and a header is through a pressure-tight joint with a steel tube. The joint between the tubes consists of an annular, axially extending pocket provided on one of the tubes and housing a length of the second tube. A locking means was adapted to inhibit relative longitudinal movement of the tubes. (M.C.G.)

**7874** IMPROVEMENTS IN TUBES FOR NUCLEAR REACTORS. Henri Foulquier, Claude Bridoux, Jacques Stohr, and Paul Thome (to Commissariat a l'Energie Atomique). British Patent 946,256. Jan. 8, 1964. Priority date Mar. 1, 1960, France.

A method of mounting a tube in a central portion of a reactor core is described. The tube has a better transparency to neutrons than steel and has a sleeve portion capable of being welded to a core part. The sleeve portion is joined to the central portion in a fluid-tight manner achieved by a mechanical tightening effect before mounting the tube in the core and by then welding or fusing the sleeve portion to the core part. (M.C.G.)

**7875** IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Bruno Reiter (to English Electric Co. Ltd.). British Patent 946,299. Jan. 8, 1964. Filed Oct. 14, 1959.

A device was designed for guiding a component axially into a hole or channel in the charge pan assembly of a nuclear reactor. A tapered guide means is mounted so as to encircle the mouth of the hole or channel whereby a component, out of alignment with the hole or channel while being fed thereto, will ride over the tapered guide thereby becoming centralized relative to the hole or channel. (M.C.G.)

**7876** IMPROVEMENTS RELATING TO CONTROL DEVICES FOR NUCLEAR REACTORS. (to General Nuclear Engineering Corp.). French Patent 1,305,950. Aug. 27, 1962. Priority date Dec. 2, 1960, United States.

A device for controlling a nuclear reactor comprises a series of control members parallelly disposed within the

reactor core such as to extend along its whole length. These control members may rotate about one or several axes parallel to their own axis. Each control member is composed of a nuclear fuel portion and an absorber portion, both extending over the whole length of it. They may be brought by rotations from a position where the absorber portions of the device mask the fuel portions, with respect to the exterior of the device, into another position in which in a similar way the fuel portions mask the absorber portions. According to a preferred embodiment, the control members disposed along a circle have a prismatic shape with semicircular cross section and rotate about the axis of that semi-circle. The fuel portion occupying almost the whole of the cross section is covered at its flat surface with an absorber plate. (IIB)

**7877** SEALING DEVICE ESPECIALLY FOR NUCLEAR REACTORS. (to Babcock and Wilcox Co.). French Patent 1,310,820. Oct. 22, 1962. Priority date Dec. 2, 1960, United States.

In liquid-cooled reactors the control rod drives are often mounted at the bottom of the reactor vessel. Each of these drives comprises sealing means allowing the sliding of the drive rod coupled with the control rod but preventing the coolant from the reactor vessel to enter the drive mechanism. Generally such a sealing device comprises a series of sealing rings through which passes a rinsing fluid flow-directed toward the reactor vessel. A second sealing device is provided that seals the drive rod passage at a given position of the rod and comprises two portions connected by coupling means, such as to allow a disassembling or change of the drive mechanism without fluid losses from the reactor vessel. Preferably the drive rod portion coupled with the control rod comprises a valve body that fits in its sealing position in a corresponding valve seating mounted in the drive rod passage. (IIB)

**7878** RADIATION SHIELD FOR NUCLEAR REACTOR INSTALLATIONS. (to General Dynamics Corp.). French Patent 1,314,191. Nov. 26, 1962. Priority date Jan. 31, 1961, United States.

A nuclear reactor installation is described that comprises a pool having a bulge in its wall enclosing a semicylindrical cavity within the pool forming the working place of the reactor core. The bulge reaches into an adjacent irradiation chamber. A movable radiation shield is provided within the radiation chamber, this shield being adapted to be brought into the trajectory of radiation emitted by the reactor core in order to modify the intensity and nature of radiation serving for irradiation. This shield suitably has a semi-annular cross section, such as to fit over the outer surface of the bulge, and is constituted of a material of a high atomic number to ensure a sufficient gamma-ray alteration. The shielding material may be disposed in the form of two plates with an interspace between them for the circulation of a cooling fluid. (IIB)

**7879** IMPROVEMENTS RELATING TO NUCLEAR REACTORS. (to Societe Belge pour l'Industrie Nucléaire "Begbo-Nucléaire" S. A.). French Patent 1,314,343. Nov. 26, 1962. Priority date Feb. 28, 1961, Belgium.

A moderator system is described, which is totally or partially distinct from the coolant either by their nature or by the fact that they circulate within circuits essentially separated from each other. The composition and the temperature of a part or the whole of the moderator are thereby adjustable independently from the composition and the temperature of the coolant. Preferably the moderator occupies within the reactor core a system of chambers, the composition of the moderator therein being changed in stages in order to compensate the burnup of the nuclear fuel charge. According to another embodiment the transition from one stage to the succeeding one is performed by taking the whole or a part of the moderator out of the reactor and replacing it by a moderator of different composition. (IIB)

**7880** NUCLEAR REACTOR MODERATOR STRUCTURES. Stanley Hackney and Peter Neil Munn (to United Kingdom Atomic Energy Authority). U. S. Patent 3,115,448. Dec. 24, 1963. Priority date July 1, 1957, Great Britain.

A device to restrain the radial movement of graphite-moderator blocks during operation of a reactor is patented. A series of wedges is placed in the moderator structure. The wedges can be displaced in a direction normal to the radial direction to permit expansion of the moderator structure in the radial direction. The displacement of the wedges is controlled by a spring-loaded thrust rod extending outside the reactor shielding, so that the spring is protected from radiation. Details of the thrust-rod design are described. (M.P.G.)

**7881** NUCLEAR REACTOR CONTAINMENT APPARATUS. Joseph L. Schanz (to General Electric Co.). U. S. Patent 3,115,450. Dec. 24, 1963. Filed Feb. 24, 1959.

A combined reactor vessel support, radiation shield, and containment structure is designed which is reduced in size but is capable of containing the most severe reactor accident in spite of possible leaks in the containment. The structure comprises a sealed inner containment with an inner chamber for the reactor core, a sealed outer containment spaced from the inner containment, a pool of liquid in the outer containment, and means for passing fluids from the core into the pool. Means may also be provided for flooding the core with liquid from the pool. Several embodiments of the structure are described. (D.L.C.)

**7882** ARRANGEMENTS FOR DETECTING RADIATION CONTAMINATION OF THE COOLANT IN AN ATOMIC REACTOR. Roland Cochinal, André Roguin, and René Donguy (to Commissariat a l'Energie Atomique). U. S. Patent 3,116,210. Dec. 31, 1963. Priority date Mar. 28, 1958, France.

An arrangement is described for detecting reactor fuel sheath failure. In the arrangement, the coolant ducts are arranged in sets and the sets into groups, and sampling circuits and switching means are provided for connecting the sets of each group to a first detector and for connecting any contaminated sets to a supervisory detector. (D.L.C.)

**7883** NUCLEAR REACTOR HEAT EXCHANGE, MODERATION, AND SHIELDING SYSTEM. John E. Lindberg, Jr. U. S. Patent 3,116,212. Dec. 31, 1963. Filed Dec. 27, 1960.

A nuclear reactor system is described which uses a single medium to accomplish all the heat exchanging and some or all of the moderation and shielding. The medium is a metallic hydride, preferably lithium or zirconium hydride, which undergoes thermal dissociation in the reactor and is passed to a heat exchanger where the exothermic recombination reaction takes place. A two-reactor system is described in which $H_2$ gas alone is transferred cyclically between the two reactors. Two embodiments of the application of the system to nuclear aircraft propulsion are shown. (D.L.C.)

**7884** GASEOUS FISSION PRODUCT ABSORPTION IN LIQUID FOR MEASUREMENT. Murray Vincent Wilson

(to Plessey Co. Ltd.). U. S. Patent 3,116,414. Dec. 31, 1963. Priority date July 27, 1959, Great Britain.

A method and an apparatus are described for detecting fission products carried in a gaseous phase, e.g., from a gas-cooled reactor. The method comprises electrostatically precipitating the daughter products of the fission products onto a surface liquid film covering an electrode, and draining the liquid into a counting device. (D.L.C.)

## Crititicality Studies

**7885** (AEEW-M-363) CARLSON CALCULATIONS ON THE ZEEP $D_2O$ LOOP. C. T. Chudley (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Aug. 1963. 13p.

A series of Carlson calculations on the ZEEP $D_2O$ loop is reported. These calculations establish that the results from Carlson's SNG code, and the Winfrith DSN code, are in close agreement for the loop; and also show that there is some difficulty in evaluating the lutetium activation unless the group set chosen is closely bunched at the low lying (0.142 ev) resonance of $Lu^{176}$. The sensitivity of the results to the source shape, as a function of energy and position, of neutrons slowing down into the thermal region, and to the scattering model chosen is also discussed. A comparison is made with experimental results, and it is shown that the predictions are in satisfactory agreement with experiment. (auth)

**7886** (AEEW-R-91) REDSHANK I AND GREENSHANK I. COMPREHENSIVE POINT REACTIVITY PROGRAMMES FOR LIQUID MODERATED $UO_2$ LATTICES. R. A. Alpiar (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Aug. 1963. 56p.

The Redshank I and Greenshank I programs that investigate the life history of the lattices are described. Burnup equations recalculate the fuel isotopic composition, in a series of steps. At each step, new few group constants and reactivity are recalculated for the new fuel composition. In addition, at each step, the control required to keep the reactivity of the reactor within a given deadband is recalculated. This control is effected by control rod withdrawal in Redshank, and by heavy water spectrum shift in Greenshank. The program continues until the reactivity of the uncontrolled reactor falls below the deadband. (auth)

**7887** (AEEW-R-92) SANDPIPER III. A PROGRAMME TO CALCULATE 5-GROUP CONSTANTS FOR LIQUID MODERATED CLUSTER FUELLED REACTORS. R. A. Alpiar and D. Hicks (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Jan. 1963. 68p.

The computer program, SANDPIPER III, which calculates effective cross sections for cell components from a detailed description of the lattice geometry and materials inventory, is described. Output from the program serves as input for the ARISTOS program, which gives group constants for reactors using low-enrichment $UO_2$ fuel clusters. (D.C.W.)

**7888** (AEEW-R-186) THE USE OF MULTI-GROUP TRANSPORT PROGRAMMES FOR THERMAL SPECTRUM CALCULATIONS ON PRESSURE TUBE REACTORS. M. J. Terry (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Sept. 1963. 39p.

Developments in the technique of using multigroup transport theory programs for calculating the thermal spectra in water lattices are described, and theoretical predictions are compared with the fine structure and spectrum characterization measurements made in the $H_2O/D_2O$ coolant loop of ZEEP. The developments concern the choice of energy group boundaries and the weighting spectrum which should be used when producing group averaged cross sections, and methods of producing the source of neutrons into the thermal region. (auth)

**7889** (AEEW-R-272) THE INTRODUCTION OF RADIAL STREAMING INTO GALANIN'S METHOD. D. C. Leslie (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Aug. 1963. 14p.

In his original formulation of small-source theory, Galanin allowed only simple source/sinks at the lattice points. The effect of streaming across air gaps can be allowed for by including dipoles as well as simple sources at these points. The calculation is performed, and a formula is derived for the radial streaming factor. (auth)

**7890** (AEEW-R-305) A DESCRIPTION OF THE TRACER-1 COMPUTATIONAL SCHEME. A. N. Buckler and J. D. Macdougall (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Sept. 1963. 19p.

The scheme incorporated into TRACER to carry out lattice calculations for gas cooled reactors is described. The scheme is based on a cell calculation using the Winfrith DSN program. It includes a data library and data processing program to provide data for the WDSN calculation, and extensive edit facilities of the DSN results to obtain reaction rates, condensed cross sections for use in reactor codes, critical bucklings, etc. (auth)

**7891** (CEA-Note-209) CALCUL DU LAPLACIEN D'UNE BARRE D'URANIUM DANS UNE CELLULE. (Calculation of the Laplacian of a Uranium Rod in a Cell). A. Amouyal and P. Benoist (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). 1957. 30p.

The diffusion of monoenergetic neutrons in U rods is studied, taking into account the effects of the cell in which the rod is situated (e.g., neutron anisotropies and rod temperature). The diffusion characteristics of the rod are given in the form of a laplacian. The study is extended to the case in which the neutrons have a spectrum of energies. (T.F.H.)

**7892** (CONF-332-3) A STUDY OF THE APPLICABILITY OF SIMPLE REACTOR KINETICS TO THE INTERPRETATION OF REACTOR NOISE EXPERIMENTS. Charles Erwin Cohn (Argonne National Lab., Ill.). [1963]. Contract W-31-109-eng-38. 16p.

From Symposium on Noise Analysis in Nuclear Systems, Gainesville, Fla., Nov. 1963.

The suitability of the simple one-energy-group point-reactor kinetics model for interpreting kinetic (primarily noise) measurements was investigated by comparing the predictions of more complex models with experimental data and simple model results. The results show that in several situations space- or energy-dependent effects could cause significant departures from the simple model. Also, the more complex models should give information on some parameters not considered by the simple model. (D.C.W.)

**7893** (DP-777) MEASURED LATTICE PARAMETERS FOR NATURAL URANIUM METAL ROD LATTICES IN $D_2O$.

T. J. Hurley, Jr. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Aug. 1963. Contract AT(07-2)-1. 46p.

The nuclear parameters of sixteen $D_2O$-moderated lattices of natural uranium rod clusters were measured in the Process Development Pile. The clusters consisted of 1, 3, 7, or 19 uranium metal rods, 1 inch in diameter and clad with 0.032 inch of aluminum. Triangular lattice spacings between clusters ranged from 7 to 21 inches, center to center. The parameters that were measured included the number of fission neutrons per thermal neutron absorption, the fast fission factor, the resonance escape probability, the thermal utilization, and the thermal diffusion area. (auth)

**7894** (IDO-16904) INHOUR—AN IBM-7090 CODE FOR THE COMPUTATION OF THE ROOTS OF THE INHOUR EQUATION. H. A. Larson and W. A. Christenson (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Aug. 20, 1963. Contract AT(10-1)-205. 49p.

A computer program that solves for the roots of the inhour equation using, as input, mean prompt neutron generation time, reactivity in the form of dollars, and as many as twenty delayed neutron groups is described. The program uses Newton's method to determine the roots with an optional convergence criterion. Parametric studies of the roots and residues associated with a solution of the time dependent reactor kinetics equations for a step input of reactivity are included. The studies are treated individually for four mean prompt neutron generation times and six delayed neutron groups. Also included is a study of the numerically largest root of the inhour equation with 15 delayed neutron groups and positive reactivity as input. The program listing is given. (auth)

**7895** (KR-59) ON THE SIMULATION OF TRANSFER FUNCTIONS FOR A DISTRIBUTED PARAMETER SYSTEM. W. Ciechanowicz (Norway. Institutt for Atomenergi, Kjeller). May 1963. 26p.

A simple method for simulating distributed parameter systems (nuclear power plants) on an analog computer is presented. The distributed transfer functions are approximated by the use of single time constant transfer functions. The type of these elementary transfer functions and the values of their parameters are chosen so as to obtain the same attenuation and phase characteristics as in the case of the distributed ones. Special emphasis is placed on the resonance frequency region of the closed loop. Only part of a boiling water reactor system is considered in the analysis. Attention is focussed on two of the feedback paths that influence the core stability through changes in reactivity: the temperature and the void reactivity effects. It is shown that the single time constant transfer functions represent the distributed parameter system in a quite satisfactory way, if the distributed parameter system transfer function is considered in the closed loop. It permits the simulation of the complex systems in a simple manner on an analog computer by use of a relatively small number of operational amplifiers. (auth)

**7896** THERMAL FLUX DISTRIBUTION IN A SUBCRITICAL FLUX TRAP ASSEMBLY WITH SPONTANEOUS FISSION SOURCE. Timo Toivanen (Inst. of Tech., Helsinki). Ann. Acad. Sci. Fennicae, Ser. A VI, No. 133, 1-11(1963).

The spatial thermal neutron flux distributions caused by spontaneous fission source in a subcritical assembly is investigated. Both the homogeneous assembly and the flux trap assembly are considered. The flux trap system was constructed by removing fuel rods symmetrically from the center of the assembly. The resulting moderator-filled cavity at the center forms the trap for the thermal neutrons. The fission neutrons from the core slow down in this trap, and, when the moderator material has a small absorption cross section for the thermal neutrons, a high thermal flux peak builds up at the center. The radial thermal flux distribution in the trap was measured with an indium foil activation technique. Measurements are compared with a theoretical curve calculated with a three-group diffusion theory. The flux trap assembly with radius optimized to give a maximum central thermal flux gives twice the flux obtainable with the homogeneous assembly. (auth)

**7897** A THEORETICAL APPROACH TO THE NEUTRON MULTIPLICATION EXPERIMENTS INVOLVING A SINGLE FUEL ELEMENT. PART I. S. E. Corno (Agip Nuclear, San Donato Milanese, Milan). Energia Nucl. (Milan), 10: 598-614(Nov. 1963). (In Italian)

The theoretical foundations for a self-consistent analysis of the neutron multiplication experiments, involving a single fuel element are given. The scope of the experiments is the measurement of such absorption and multiplication constants which occur, for a given fuel element, as input parameters in the heterogeneous reactor theories. Calculations of thermal and epithermal fluxes within the volume of a thermal column, which contains a fuel element along its axis, were made. (auth)

**7898** STUDY OF A SUBCRITICAL ASSEMBLY BY THE METHOD OF CHARACTERISTIC FREQUENCY. I. Purica, N. Seferian, and E. Racataianu. [Vienna,] International Atomic Energy Agency, 1963, Preprint SM-42-68, 21p. (CONF-133-37). (In French)

From International Atomic Energy Agency Symposium of Exponential and Critical Experiments with Calculations, Amsterdam, Sept. 1963.

## Design and Feasibility

**7899** (AEEW-R-196) THE ROLE OF A FUEL ELEMENT AND ITS CLADDING IN WATER-COOLED REACTOR DYNAMICS. J. Randles (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Oct. 1963. 34p.

The heat diffusion and transfer equations are solved in slab geometry for an oscillatory fission power and an oscillatory coolant temperature. From the resulting transfer functions a clear description of the effect of the cladding on the heat flow is obtained. A Mercury autocode program for evaluating the transfer functions is described. The heat diffusion equations are also solved for a cylindrical system exposed to an oscillatory fission power. The solutions are expressed as transfer functions and are obtainable numerically from another autocode program. Both of these programs are used to obtain the power-out/power-in transfer function for a typical cylindrical and slab $UO_2$ fuel pellet clad in Zircaloy. The results give a further indication of the effect of the cladding heat capacity over a wide frequency range. It is shown also that the effect of the geometrical difference between a slab and cylindrical fuel element is unimportant provided the surface to volume ratio of the fuel is the same in each case. (auth)

**7900** (HW-SA-3149A) SEGMENTED CORE DESIGN FOR A SUPERCRITICAL PRESSURE WATER-COOLED FAST REACTOR. R. E. Peterson and S. L. Stewart (General Electric Co. Hanford Atomic Products Operation,

Richland, Wash.). Oct. 3, 1963. Contract AT(45-1)-1350. 16p. (CONF-334-5)

From Conference on Breeding Economics, and Safety in Large Fast Power Reactors, Argonne, Ill., Oct. 1963.

The results of a conceptual design study of a reactor using steam coolant above the critical pressure (Fast Supercritical Pressure Power Reactor) and of evaluations of the reactor's economics and safety are summarized. A reactor with massive fuel elements pierced by small high-pressure coolant tubes and with a core subdivided by a relatively thin layer of moderating material was considered. (D.C.W.)

**7901** (KR-54) DIFFERENCE-DIFFERENTIAL APPROXIMATIONS TO A FIRST ORDER PARTIAL DIFFERENTIAL EQUATION DESCRIBING THE HYDRAULICS OF BOILING WATER REACTORS. P. Bakstad (Norway. Institutt for Atomenergi, Kjeller). Nov. 1963. 22p.

The development of a dynamical model for boiling water reactors is studied. Two simple methods for solving the partial differential equations arising in such models on an analog computer are discussed, both in the frequency and the time domains. (auth)

**7902** EXPECTED PERFORMANCE OF THE SSCR. R. A. Webb (Babcock and Wilcox Co., Lynchburg, Va.). 18p. (CONF-360-1)

From American Nuclear Society Topical Meeting Nuclear Performance PF Power Reactor Cores, San Francisco, Sept. 1963.

Experimental justification of the principle of spectral shift control is presented. Core description and control, fuel cycles, and the future program on the SSCR thorium system are discussed. (R.E.U.)

## Fuels

**7903** (CONF-360-4) MEASUREMENT METHODS OF BURNUP AND HEAVY ELEMENT ISOTOPIC COMPOSITION IN IRRADIATED POWER REACTOR FUELS. B. F. Rider, C. P. Ruiz, and H. W. Alter (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). [1963]. Contract AT(04-3)-189. 19p.

From American Nuclear Society Topical Meeting Nuclear Performance Power Reactor Cores, San Francisco, Sept. 1963.

Methods for determining the heavy element isotopic compositions and atom percent fission for reactor fuels are briefly described, and their accuracies are discussed. (D.C.W.)

**7904** (CONF-360-5) FUEL MANAGEMENT IN LARGE PRESSURIZED WATER REACTORS. W. J. Dollard and L. E. Strawbridge (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). [nd]. Contract AT(30-1)-3070. 25p.

From American Nuclear Society Topical Meeting, Nuclear Performance Power Reactor Cores, San Francisco, Sept. 1963.

Economic and operational ground rules and their effects on fuel management are summarized, and examples showing the approach to typical fuel management problems are presented. The problems associated with in-core fuel management are also discussed, and the merits of various fuel cycling methods are evaluated. (D.C.W.)

**7905** (GA-4619) IMPROVEMENT IN THERMAL PERFORMANCE OF A NUCLEAR REACTOR BY LOCAL CHANGES IN SURFACE HEAT TRANSFER PROPERTIES. G. B. Melese (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Dec. 10, 1963. Contract AT (04-3)-187. 56p. (CONF-187-29)

From American Nuclear Society Meeting, New York, Nov. 1963.

Nuclear reactor performance may be improved by increasing the surface heat transfer coefficient, but only at the cost of an increase in pressure drop or pumping power. It is shown that the same improvements may also be obtained at reduced pumping power by using multiregion fuel channels, the surface heat transfer properties being gradually improved in the direction of flow. For instance, the maximum fuel temperature may be decreased by roughening the surface of the fuel elements in such a way as to double the surface heat transfer coefficient. The pumping power is usually tripled when the rod is completely roughened, but is could be only doubled by using a smooth rod at the cold end of the channel, then partially roughening it, and completely roughening it only at the hot end. (auth)

**7906** (RT/CHI(63)-22) METODI PER LA DETERMINAZIONE DEL BURN-UP. (Methods for the Determination of Burn-up). G. Pugnetti (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). June 1963. 32p.

Five methods are described for determining fissionable material burn-up in irradiated fuel. Theoretical assumptions, experimental difficulties, applicability to various irradiation programs and accuracy are discussed. To remove the ambiguity in burn-up definition and analytical procedures, the fission density and radiochemical analysis of $Cs^{137}$ are recommended, respectively. (auth)

**7907** (EURAEC-709) CHARACTERIZATION OF THE MECHANICAL STRENGTH OF A DISPERSION FUEL ELEMENT. Special Report No. 12. (Brussels. Centre d'Etude de l'Energie Nucleaire and Société Belge pour l'Industrie Nucléaire, Brussels). [1962]. Work Performed under United States–Euratom Joint Research and Development Program. 23p. (A translation)

The interaction between a discontinuous medium and stress is studied with the help of rubber models. The appearance of concentrations of triaxial stress is clearly shown. The incidence of these effects on the rupture of the matrix and on the particle diameter is examined. The nature of the stress induced in-pile in a dispersion fuel element and its reaction toward this stress are reviewed. From this review result several essential physical and mechanical properties and especially the resistance to cracks. Finally, various quality factors are proposed as criteria for the evaluation of a matrix alloy. (auth)

**7908** FUEL CYCLES FOR WATER REACTORS. R. W. Deuster and P. F. Schutt (Babcock and Wilcox Co., Lynchburg, Va.). New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-241, 8p, $1.00. (CONF-102-23)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

There are three possible fuel-management concepts for enriched-fuel power reactors. They are thorium cycle (uranium recycle), plutonium recycle, and low enriched-uranium cycle. Only thorium cycle can achieve conversion ratios in excess of 0.8 in a thermal or near-thermal neutron spectrum. The relative performance of the low-enriched cycle and plutonium recycle, as utilized in low neutron-efficiency reactors such as the PWR, is compared to uranium recycle in a high-neutron efficiency reactor such as the SSCR. Three standards of comparison are used: fuel costs; stability of natural uranium-ore costs

over plant life; and government influences. In each instance, thorium cycle offers superior performance. (auth)

**7909** IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Anthony Francis Taylor and Guy Rudguard Webster (to United Kingdom Atomic Energy Authority). British Patent 944,516. Dec. 18, 1963. Filed Mar. 6, 1961.

A reactor fuel element of the polyzonal helical finned type is designed for improved stability in coolant flow. Each of the longitudinal splitter fins of the fuel element has a flange in the region of its outer edge, all the flanges extending in the same rotational direction (clockwise or anticlockwise). (D.L.C.)

**7910** IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. John David Bell (to Babcock and Wilcox Ltd.). British Patent 944,699. Dec. 18, 1963. Filed Aug. 27, 1959.

A fuel element assembly of the sleeve-fuel rod type is designed for gas-cooled reactors. In the assembly, the fuel rods form a single unit which can be removed or inserted into the sleeve. The fuel rods are secured between spaced grids in such a manner that differential thermal expansion is allowed. (D.L.C.)

**7911** FUEL ELEMENTS FOR NUCLEAR REACTORS. Leslie Mark Wyatt and Malcolm Douglas Jepson (to United Kingdom Atomic Energy Authority). U. S. Patent 3,114,688. Dec. 17, 1963. Priority date May 13, 1958, Great Britain.

A method of enclosing a nuclear fuel member in a sheath is patented. The sheath material is extruded through a die using the nuclear fuel member as the mandrel. The die has axially extending slots, and the fuel member is rotated during the extrusion to form longitudinal helical fins of sheath material. This method simplifies the manufacture of fuel elements and brings the fuel into close contact with the sheath. (M.P.G.)

**7912** CERAMIC FUEL FOR NUCLEAR REACTORS. Lawrence H. Cope (to United Kingdom Atomic Energy Authority). U. S. Patent 3,114,689. Dec. 17, 1963. Priority date June 26, 1959, Great Britain.

A method of making a ceramic fuel element using a binder of gelatinous fissionable material is patented. $UO_2$ powder is ball milled with ~2% by weight of a gelatinous Pu polymer, which may be either the quadrivalent hydroxide or hydrated oxide. The mixture is pressed to form a green compact and then sintered to convert the quadrivalent Pu to $PuO_2$. The improved sintering characteristics of the green compacts permit the use of stoichiometric $UO_2$, which resists radiation damage better than the nonstoichiometric oxide. (M.P.G.)

**7913** FUEL ELEMENTS FOR NUCLEAR REACTORS. Frank Butler (to United Kingdom Atomic Energy Authority). U. S. Patent 3,114,690. Dec. 17, 1963. Priority date July 24, 1959, Great Britain.

A method for manufacturing sheathed fuel elements containing He for leak detection is patented. The sheath containing the fuel is evacuated and then filled to atmospheric pressure with a mixture of 5% He and 95% O by volume. The sheath is completely sealed, and the fuel element is heated, so that the O is taken up by the fuel. In this way only a minor quantity of the leak-testing He is inside the sheath, and excess pressures are not built up within the sheath with further heating. (M.P.G.)

**7914** HEAT EXCHANGE ELEMENTS SUITABLE FOR USE AS FUEL ELEMENTS FOR NUCLEAR REACTORS. Heinrich Hugo Ludolf Ritz (to C. A. Parsons and Co. Ltd.). U. S. Patent 3,116,213. Priority date May 21, 1957, Great Britain.

A fuel element with improved heat exchange properties is designed for gas-cooled graphite-moderated reactors. The element comprises a graphite container and four finned fuel containers arranged side by side in the graphite container. Coolant gas is circulated inside the graphite container. (D.L.C.)

## Power and Power-Breeder Reactors

**7915** (AAEC/TM-222) FURTHER EXAMINATION OF H.T.G.C.R. FUEL CYCLE COSTS. W. J. Wright (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Nov. 1963. 17p.

The equation previously developed for High Temperature Gas-Cooled Reactor Experiment fuel costs was modified and applied to heterogeneous fuel systems. Fuel costs are reduced by 20–25% in these systems relative to the homogeneous systems; these advantages arise from the longer life that may be assumed for the unfueled beryllia and cheaper fabrication costs. The effects of reduced beryllia costs on fuel cycle costs are also examined. (auth)

**7916** (AEEW-R-237) REACTIVITY AND REACTION RATE STUDIES ON THE FOURTH LOADING OF ZENITH. I. R. Cameron, R. G. Freemantle, D. L. Reed, and D. J. Wilson (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Aug. 1963. 119p.

The determination of the excess reactivity, control rod worths, prompt neutron lifetime, flux fine structure, and reaction rates of various nuclides for the fourth loading of the heated zero energy reactor ZENITH is described. The core contains 7.76 kg of $U^{235}$, giving a carbon/$U^{235}$ atom ratio of 7578, and is the most dilute core studied. Comparisons of the experimental results with calculations using multigroup diffusion codes are presented. (auth)

**7917** (ANL-6721) A PERFORMANCE ANALYSIS OF THE EBWR AT VARIOUS POWER LEVELS. Alfred A. Nentwich (Argonne National Lab., Ill.). Oct. 1963. Contract W-31-109-eng-38. 40p.

An attempt was made to predict the operating performance of EBWR at various power levels, and the results are compared with the experimental data obtained in raising the EBWR to a power of 100 Mw. An IBM-704 code, RECHOP, was used to calculate the recirculating velocity; experimental subcooling data were fed into RECHOP at high power levels. It is concluded that the prediction shows the general trend of the major parameters but requires further work for producing accurate answers. (D.L.C.)

**7918** (BNL-7571) FUEL STUDIES UNDER THE SETTLED-BED REACTOR CONCEPT. G. Pancer and R. Powers (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract AT-30-2-GEN-16. 13p. (CONF-334-15)

From Conference on Breeding Economics, and Safety in Large Fast Power Reactors, Argonne, Ill., Oct. 1963.

Commercially available UC spheres ($\frac{1}{8}$-in. diameter) prepared by arc melting or powder metallurgy were examined chemically and metallographically and were tested for strength and sodium compatibility. Crushing tests showed that the arc-melted carbide was the stronger of the two. Exposure to NaK at 150 to 760°C had no adverse effects on either type of pellet. An in-pile capsule was developed for

irradiating pellets in the Brookhaven Graphite Reactor under simulated bed reactor load conditions. (D.C.W.)

**7919** (CONF-243-38) DETECTION AND IDENTIFICATION OF A RUPTURED FUEL ELEMENT AT THE SM-1 (APPR-1) NUCLEAR POWER PLANT. Leo J. Misenheimer, Robert A. Purple, and Paul S. Brown (Corps of Engineers). [1961]. 15p.

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

In October 1960, increases in the fission product activity of the primary coolant of the SM-1 power plant indicated that a fuel element failure had occurred. Low power tests were run first to determine the nature and the magnitude of the defect. Flux tilting experiments were then performed to determine the general location of the failed element. Finally, the primary coolant flowing through each of the fuel elements was sampled at a low reactor power for relative iodine activity to determine the exact location of the defective element. The element was found and replaced. Upon return to power, the fission product activity dropped back to its normal full power value. (auth)

**7920** (CONF-360-3) SIMPLIFIED ANALYTICAL MODEL FOR SIMULATION OF BOILING WATER REACTORS. D. L. Fischer and J. M. Harriman (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). [nd]. Contract AT(04-3)-361. 19p.

From American Nuclear Society Topical Meeting, Nuclear Performance Power Reactor Cores, San Francisco, Sept. 1963.

A digital computer program FLARE was developed for calculating the core reactivity and power distributions in the Big Rock Point Reactor. The calculations are restricted to a relatively coarse mesh, but good agreement was obtained in comparisons with operating data from the Kahl reactor. (D.L.C.)

**7921** (CONF-360-6) OPERATING STRATEGY FOR MAINTAINING AN OPTIMUM POWER DISTRIBUTION THROUGHOUT LIFE. R. K. Haling (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). [nd]. Contract AT(04-3)-361. 8p.

From American Nuclear Society Topical Meeting, Nuclear Performance Power Reactor Cores, San Francisco, Sept. 1963.

A method of operation developed for maintaining a minimum power peaking factor throughout the operating cycle of a power reactor is described. The basic operating principle for peaking factor minimization is presented, and its use in the design phase to compare and set design parameters and in the operational phase to establish control rod patterns is outlined. The method will (hopefully) increase the power density in the Big Rock Point Reactor. (D.C.W.)

**7922** (CONF-360-7) APPLICATIONS OF MONTE CARLO CALCULATIONS TO SGR REACTORS. F. L. Fillmore (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). [nd]. Contract AT-11-1-GEN-8. 33p.

From American Nuclear Society Topical Meeting Nuclear Performance Power Reactor Cores, San Francisco, Sept. 1963.

Monte Carlo (MC) calculations were made that show that an observed reactivity increase due to fuel rod bowing in the Sodium Reactor Experiment can be accounted for by the accompanying change in the thermal flux distribution. The questionable reliability of calculations with a simplified fuel element model that indicated the same relation prompted the MC calculations. Comparison with experimental results and results calculated by other means established the reliability of the MC calculations. (D.C.W.)

**7923** (CVNA-193) SIX MONTHS OPERATING REPORT, MARCH 30–SEPTEMBER 30, 1963. (Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.). 47p.

Initial criticality was achieved on March 30, 1963. The six-month period following was devoted to a series of low-power physics tests, calibrations, and initial operation of various auxiliary plant components. The results of tests made to date were within the range of values originally anticipated and operation of the nuclear plant was satisfactory. Three areas that required considerable effort and/or created major delays were the failure or near failure of various heat exchangers, excessive gas leakage from the header cavity, and considerable rework and checkout of refueling equipment and handling tools. Plant chemistry results generally fell within operating limits. Radiation survey results all indicated close to background conditions. (auth)

**7924** (CVNA-194) MONTHLY OPERATING REPORT, OCTOBER 1963. (Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.). 36p.

The work of sealing off the header cavity leakage was successfully concluded. The shutdown cooling and component cooling water heat exchangers were re-installed and the reactor was run at mid-month for operator training. Startup test, SU-CV-48, "Initial Orificing and Non-Nuclear Heat Losses" was begun. A complete checkout of the refueling machine and related equipment was started. (auth)

**7925** (CVNA-197) MONTHLY OPERATING REPORT, NOVEMBER 1963. (Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.). 35p.

The reactor was operated for the performance of startup tests and for the AEC operator's examination. A checkout of the refueling machine and related equipment was completed. Radiation and air contamination levels in the plant increased due to the reactor operation and refueling work performed. System chemistry analyses were generally within specifications although some discrepancies were noted due to the fact that some systems were not operating. Chemical analyses revealed slight fluoride contamination in the moderator. (auth)

**7926** (GA-3307) EXPERIMENTAL BERYLLIUM OXIDE REACTOR PROGRAM. Quarterly Progress Report for the Period Ending June 30, 1962. (General Atomic Div. General Dynamics Corp., San Diego, Calif.). July 26, 1962. Contract AT(04-3)-187. 100p.

Attention is given to developmental activities, physics calculations, critical-assembly studies, component development and testing, and materials development and testing. (T.F.H.)

**7927** (GEAP-4391) HIGH POWER DENSITY DEVELOPMENT PROJECT. Fourteenth Quarterly Progress Report, July–September 1963. R. L. Holladay, comp. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Sept. 1, 1963. Contract AT(04-3)-361. 59p.

The number of Task 1A assemblies included for continued irradiations in the VBWR was reduced from nine to seven as a result of the failure of pellet fuel assemblies 2C and 3C. Assemblies currently operating are 1A, 2A, 1B, 2B, 1C, and 1F. Assembly 4C, suspected to be a leaker as

a result of sipping tests, is to be reinserted based on soundness in visual and ultrasonic examinations. The average burnup of the group operating as of September 1 is 7500 Mwd/t. Special assemblies 12S and 1SM-1 were inserted in VBWR. Assembly 11S, after rebuilding at RML, was delivered to VBWR for insertion. Assemblies 1SM-1, 4S, and 9S, operated without incident, but 12S gave positive signals of being a leaker under the multi-tube in-core sampler. Later, 12S was declared a failed assembly based on the in-core results and visual observation of a cracked rod. Modifications to the instrumented fuel assembly probes were made by removing the failed flow meter rotors to allow continued use of the flux detectors and thermocouples. A series of noise recordings of fluxes, flows, and temperatures were made at 91 Mw(t) at the Big Rock Point plant. Thermocouple response tests were performed to verify the temperature measurements. A simple procedure was devised for improving the agreement between calculated power distribution and the results of the gamma scan. The first eight R and D assemblies were verified to determine their relative reactivity, and then loaded into the core. The relationship between power and flow for fixed control rod position was investigated to evaluate the feasibility of flow control. The technique shows considerable promise, at least over the range from 50% to full power. Enrichment requirements for the Phase II R and D fuel bundles were estimated for several cladding possibilities. Plans for achieving optimum performance from the Big Rock plant are being based on the concept of maintaining a fixed power shape throughout each operating cycle. The desired shape for the present cycle was computed. Methods of selecting control rod patterns to maintain this shape are being investigated for use in the on-line computer. Several errors in the on-line computer program were discovered and corrected. The plant performance, xenon transient, and control rod sequence program were written, assembled and de-bugged; and the programs for several periodic logs were written and assembled. The computer was put on line during plant startup in August, and is presently performing satisfactorily, with the loss of only a few calculational cycles. Eight developmental fuel assemblies were delivered, installed, and verified; and three instrumented assemblies were modified and installed in the Big Rock Point core. The on-line computer successfully completed the 99% availability test over a 6-month period. Re-evaluation and verification of the operating limits for the Phase I tests is being made. Phase II operational testing at Big Rock Point is being defined and will depend in part on results forthcoming from the Phase I test. (auth)

**7928** (GNEC-257) CHLORIDE CORROSION EFFECTS ON BONUS SUPERHEATER MATERIALS. Terminal Report. Frank Bevilacqua and G. M. Brown (General Nuclear Engineering Corp., Dunedin, Fla.). Apr. 10, 1963. Contract AT(40-1)-2674. 103p.

An experimental investigation was made on the ability of the BONUS type dryer-preheater system to prevent moisture carryover and chloride deposition on the BONUS type 348 stainless steel-clad superheater fuel elements. Dryer performance data and some corrosion data for types 304 and 347 stainless steel and Inconel were also obtained. A dryer-preheater mockup containing various preheater materials was used, and the inlet steam had 5 to 300 ppb chlorides, up to 1000 ppb total solids, and varying oxygen contents. The results indicate the following: The dryer reduces the BONUS steam moisture content to less than 0.1 wt % before it enters the preheater. The BONUS preheater with Inconel tubes should be satisfactory, while types 347 and 304 stainless steel undergoes severe stress corrosion cracking and pitting; oxygen appears to be the accelerating agent in the corrosion. Drying and slightly superheating the inlet steam will reduce the deposition of chlorides on the superheater fuel element clad by a factor >100. However, some deposition onto the fuel elements must be expected from drying of the water remaining in the BONUS fuel assemblies after unflooding these assemblies. (D.L.C.)

**7929** (HW-78962(p.6.11-19)) PRTR PRESSURE TUBES. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Ten pressure tubes were discharged from the PRTR for destructive evaluation of the PRTR environment upon their bursting properties. Property values measured from burst tests of specimens taken from the 9th and 10th tubes discharged are reported and are compared with similar data from burst tests of previous tubes discharged. These data show that the strength at the burst of specimens with annealed microstructures is approaching, with increasing fast neutron exposure, the strength at the burst of specimens with cold-worked microstructure. The room temperature hoop strain at the burst is shown to be undergoing a similar type change. The strength and hoop strain distinction between the annealed and cold-worked microstructure of the Zircaloy-2 PRTR pressure tubes is disappearing with increasing exposure to the PRTR environment. (auth)

**7930** (NP-13424) GAMMA AND NEUTRON HEATING IN THE SNOW DURING PM-2A REACTOR OPERATION. D. N. Ferguson (Alco Products, Inc., Schenectady, N. Y.). Aug. 20, 1959. 15p. (AP-Note-172)

Heating in the snow in a radial direction out from the center and in the axial direction under the core was calculated. The contributions of primary shield and coolant gammas, gammas produced by capture in the snow, and neutron flux leakage from the primary shield were considered. Numerical results are included. (D.C.W.)

**7931** (PRDC-TR-74) MONTHLY TECHNICAL REPORT, AUGUST 1963. (Power Reactor Development Co., Detroit). Contract AT(11-1)-476. 11p.

A fine-screen filter subassembly was withdrawn from the core of the Fermi reactor for examination of particulate matter, and hydrogen evolution was measured. The purity of the sodium in the Fermi reactor and its analysis were studied. The initial loading of the reactor to criticality and its subsequent operation are described. Brief descriptions are given of the computer programs. The status of various systems is reported. Thermal shock tests on zirconium cladding after hydrogen pickup did not result in visible damage. The design and testing of other components are reported briefly. Sodium-flow endurance tests of a floating subassembly and magnetostriction cavitation tests of type 347 stainless steel in sodium are described. (D.L.C.)

**7932** (WAPD-MRP-106) PRESSURIZED WATER REACTOR (PWR) PROJECT TECHNICAL PROGRESS REPORT FOR THE PERIOD AUGUST 24, 1963 TO OCTOBER 23, 1963. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Contract AT-11-1-GEN-14. 137p.

Progress on the Shippingport Pressurized Water Reactor is reported. Topics covered include: plant modification, plant decontamination, reactor engineering, metallurgy of core materials, core operation, and reactor physics. (N.W.R.)

**7933** (AEC-tr-6235) THE FUEL CYCLE IN FAST NEUTRON REACTORS. E. Grison, J. Gaussens, and J. DeDuc. Translated for Oak Ridge National Lab., Tenn., from Paper Presented at the Meeting of the European Society of Atomic Energy on "Fuel Cycles for Power Reactors," Baden-Baden, Sept. 1963. 28p.

An economic analysis of the fuel cycle, excluding the plutonium cost, show that the fuel cycle cost will not be too great if the burnup exceeds 5% and the price of processing and remanufacture does not exceed $6/g Pu. Also, breeding gains of 1.4 to 1.5 will make the fuel cycle favorable in spite of the heavy fuel investment. (D.C.W.)

**7934** ADSORPTION PLANT IN NUCLEAR POWER STATIONS. AEI (Assoc. Elec. Ind.) Eng., 3: No. 6, 299-301(Nov.-Dec. 1963).

An adsorption system for the removal of water vapor from gases is described. Applications include preparation of reactor shell, continuous treatment of heat transfer gas stream, and prevention of radioiodine emission. The solid adsorption principle is used in nuclear power stations to protect hydrogen-cooled alternators, air-cooled control systems, and servo systems. (R.E.U.)

**7935** THERMAL EXAMINATION OF THE COMBINED NUCLEAR AND THERMAL POWER PLANTS. Laszlo Perneczky. Energia Atomtech., 16: 309-12(July 1963). (In Hungarian)

**7936** PRELIMINARY REMARKS ON THE FOG COOLING OF A POWER REACTOR. I. Casagrande (Laboratori CISE, Segrate, Milan). Energia Nucl. (Milan), 10: 585-97(Nov. 1963).

Preliminary remarks on the fog cooling of a power reactor are presented, which are based on experimental data obtained at CISE on coolant in circular conduits. The relationships among the significant parameters of the fuel elements were investigated. Particular attention was devoted to the eventual reduction of the $H_2O$/uranium mass ratio along with the related effects. The study was limited to tubular metal fuel elements. (auth)

**7937** MOLTEN-SALT REACTOR EXPERIMENT. E. S. Bettis and W. B. McDonald (Oak Ridge National Lab., Tenn.). Nucleonics, 22: No. 1, 67-70(Jan. 1964).

Materials and components used in the MSRE are described and design data are given. The objectives of the program are discussed. (P.C.H.)

**7938** THE EFFECT OF REGENERATION AND HUMIDITY ON THE YIELD OF SATURATED STEAM TURBINES FOR NUCLEAR PLANTS. Roberto Breglia (Università, Naples). Riv. Ing. Nucl., 1: 129-34(May-June 1963). (In Italian)

The effects that the humidity and a regeneration thermodynamic cycle can have on the yield of a saturated steam turbine installed in a nuclear plant are studied. Emphasis is placed on the technological problems encountered. The reactor types considered are the BWR and PWR. (J.S.R.)

**7939** CHEMISTRY AND CHEMICAL ENGINEERING APPLIED IN HIGH-TEMPERATURE GAS-COOLED NUCLEAR-POWER REACTORS. H. De Bruijn (Atomic Energy Establishment, Winfrith, Dorset, Eng.). Trans. Inst. Chem. Engrs. (London), 41: 96-107(1963).

The general design features of a high temperature gas-cooled nuclear power reactor are given. Some of the main chemical problems connected with a high-temperature gas-cooled graphite-moderated reactor are mentioned. Some design details of the Dragon reactor and the General Atomic reactor that are connected with these chemical problems are mentioned briefly. The removal on a technical scale of the impurities introduced in the coolant during reactor operation and of the fission products by delay and trapping is discussed. In particular, attention is given to the use of low-temperature adsorption techniques. The use of beryllium oxide as a substitute for graphite in certain vital parts of the reactor is discussed briefly. (auth)

**7940** A PHILOSOPHY OF NUCLEAR-REACTOR SAFETY. Robert E. Trumble and Floyd D. Robbins (General Electric Co., Richland, Wash.). Trend Eng. Univ. Wash., 15: No. 4, 11-16(Oct. 1963).

Nuclear reactor safety criteria developed at Hanford is presented. The Hanford N-Reactor is used as an example of the application of these criteria. (C.E.S.)

**7941** BOILING NUCLEAR SUPERHEATER (BONUS) REACTOR. (Engineering Materials). (General Nuclear Engineering Corp., Dunedin, Fla.). (CAPE-1021)

Thirty-two specifications and 109 drawings are included. The BONUS Reactor is designed for net electric output of 16.3 Mev, to deliver 152,000 lb/hr of steam at 850 psig, and 50 Mwt with a plant efficiency of 32%. The reactor is located in a containment structure with a hemispherical dome. The structure will house the nuclear reactor, turbine-generator, control room, and most of the associated equipment systems and service rooms of the nuclear power plant. The pressure vessel is made of 2.75 in. thick carbon steel that is clad internally with 0.25 in. stainless steel. It is 7 ft ID, 27.5 ft high, and weighs 57 tons. The reactor is controlled by 17 stainless steel rods containing 2% boron. (P.C.H.)

**7942** SEISMIC DESIGN CRITERIA FOR NUCLEAR POWER REACTORS. R. A. Williamson (Holmes and Narver, Inc., San Francisco). 48p. (CONF-359-1)

From American Society of Civil Engineers Annual Meeting, San Francisco, Oct. 1963.

The nature of nuclear power reactors demands an exceptionally high degree of seismic integrity. Considerations involved in defining earthquake resistance requirements are discussed. Examples of seismic design criteria and applications of the spectrum technique are described. (auth)

**7943** INDIAN POINT REACTOR STARTUP AND PERFORMANCE. J. C. Deddens and M. L. Batch (Babcock and Wilcox Co., Lynchburgh, Va.). 35p. (CONF-357-2)

From National Power Conference Cincinnati, Sept. 1963. American Society of Mechanical Engineers Institute of Electrical and Electronics Engineers.

The testing program for the Indian Point Reactor is discussed. The thermal and hydraulic evaluation of the primary coolant system is discussed. Analyses of fuel loading and initial criticality, measurement of operating coefficients of reactivity, control rod group reactivity worths, and xenon evaluation are presented. (R.E.U.)

**7944** COMPARISON OF NUCLEAR PERFORMANCE WITH CALCULATIONS FOR THE CETR (INDIAN POINT REACTOR). H. S. Barringer (Babcock and Wilcox Co., Lynchburg, Va.). 41p. (CONF-360-2)

From American Nuclear Society Topical Meeting Nuclear Performance PF Power Reactor Cores, San Francisco, Sept. 1963.

Analytical results and experimental performance of the core of the Consolidated Edison Thorium Reactor are compared in areas of excess reactivity and reactivity components, power distributions, and control rod worths.

information relative to the expected core lifetime compared to the operating core lifetime is presented. (R.E.U.)

**7945** THE CONTROL RODS FOR THE ENRICO FERMI ATOMIC POWER PLANT. W. H. Jens (Atomic Power Development Associates, Inc., Detroit and D. H. Rhoads, Inc.). New York, American Society of Mechanical Engineers, 1963, Preprint Paper No. 63-WA-265, 12p, $1.00. (CONF-102-17)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

A description of the Fermi reactor is given with emphasis placed on the design of its control rods. The safety rods and control rods are similar in design; therefore, the safety rods are discussed in detail and the control rods only briefly. Some problems encountered in designing control rods for large fast reactors and the philosophy behind the design of the Fermi reactor control rods are discussed. A general description of the safety rods, their design characteristics, a safety analysis, and their operation are discussed. (R.E.U.)

**7946** ECONOMICS AND SAFETY ASPECTS—LARGE CERAMIC U–Th FAST BREEDER REACTORS. G. A. Sofer, A. H. Kazi, and J. Bobker (United Nuclear Corp., White Plains, N. Y.). 34p. (CONF-334-11)

From Conference on Breeding Economics, and Safety in Large Fast Power Reactors, Argonne, Ill., Oct. 1963.

Operational and safety characteristics of fast $U^{233}$–$Th^{232}$ sodium-cooled breeder reactors are discussed with emphasis on $Pa^{233}$ and $U^{232}$ buildup. A 315-Mwe reference design of 36.5% efficiency and the conceptual characteristics of a 1000-Mwe breeder are discussed. (R.E.U.)

**7947** THE VENTED-CONTAINMENT CONCEPT USED FOR THE NEW PRODUCTION REACTOR. George T. Lewis, Jr. (Burns and Roe, Inc., New York). New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-229, 8p, $1.00. (CONF-102-25)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

The "vented-containment" concept adopted in designing the New Production Reactor at Hanford, Washington, is described. This alternative approach to complete containment of the reactor and primary coolant system was conceived because of the size and prohibitive cost of the sphere that would otherwise have been required. (auth)

**7948** THE PRTR AND PRCF CONTROL AND SAFETY ROD DRIVES. D. E. Rasmussen and L. D. Gustafson (General Electric Co., Richland, Wash.). New York, American Society of Mechanical Engineers, 1963, Paper No. 63-WA-235, 8p, $1.00. (CONF-102-26)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

The four types of control and safety-rod assemblies used in the Plutonium Recycle Test Reactor and the Plutonium Recycle Critical Facility are described. All use ball-bearing lead screws driven by small electric motors. Three different lead-screw materials are discussed. Two different position indication systems are used. Testing and operating experiences are described. (auth)

**7949** MECHANICAL DESIGN OF LARGE PRESSURIZED WATER REACTOR INTERNALS. B. L. Silverblatt (Westinghouse Electric Corp., Pittsburgh). New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-253, 5p, $1.00. (CONF-102-20)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

The internal structures for a large pressurized-water reactor are described. Installation of this equipment at Selni's Enrico Fermi Nuclear Power Plant in Italy is described, with core loading and criticality scheduled for early 1964. The mechanical design effort in this project is discussed from the conceptual design stage through fitup with the reactor vessel. Structural differences in the internal structure, as contrasted with the Yankee plant at Rowe, Mass., are noted. (auth)

**7950** SOCIETA' ELETTRONUCLEARE ITALIANA (SELNI) PROJECT ENRICO FERMI TRINO VERCELLESE, ITALY-RADIOACTIVE WASTE DISPOSAL. Antonio Rani (Societa' Elettronucleare Italiana, Milan) and Ira G. Stubbart. New York, American Society of Mechanical Engineers, 1963, 13p, Preprint 63-WA-201, 13p, $1.00. (CONF-102-21)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

A comprehensive description is given of the Italian Enrico Fermi project, embodying a pressurized-water reactor with a thermal equivalent of 843,000 kw. Initially a 186,000-kw turbine-generator set will be operated and later an additive 86,000-kw set will be powered by the same reactor. The plant is well under way, the first unit going into operation early in 1964, the second following shortly thereafter. (auth)

**7951** IMPROVEMENTS RELATING TO NUCLEAR POWER PLANTS. Albert Vandeghen and Nicolas Salier. British Patent 945,643. Jan. 2, 1964. Priority date Jan. 16, 1959, Belgium.

A nuclear power plant for producing superheated steam is designed with means for continuing such production even after the reactor is shut down. The superheated steam is produced by a conventionally fueled independent superheater, and means is provided for operating the superheater as a water boiler when the production of saturated steam by the reactor is terminated. (D.L.C.)

## Process Heat Reactors

**7952** (CONF-117-29) AN EVALUATION OF THE PRODUCTION OF HYDROGEN BY GASIFICATION OF COAL USING NUCLEAR HEAT. W. H. Heffner, L. J. Pieroni, R. P. Griffin, and G. T. Skaperdas (Kellogg (M. W.) Co., New York). [1963]. Contract [AT(30-1)-3009(2)]. 36p.

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

Results are reported of a study to determine the most economical method of utilizing nuclear heat to gasify a West Virginia bituminous coal and a North Dakota lignite to produce hydrogen of 99% purity. Heat is transferred from a high-temperature, gas-cooled nuclear reactor to the solid-fuel gasification plant by a stream of 435-psig helium heated to a maximum temperature of 2500°F. There is no in-reactor processing involved; hence, radioactivity in the processing plant is assumed to be negligible. It is concluded that the gasification may be carried out more economically in a fluidized bed containing immersed heat-transfer tubes than in either a fixed-bed or an entrained-bed gasifier. Excluding the nuclear reactor, total plant investment to produce 325,000,000 standard cubic feet of hydrogen per day from bituminous coal is about $84,000,000; from lignite, about $90,000,000. If nuclear heat costs 50 cents per million Btu (cents/MMBtu), hydrogen can be produced from $5 per ton bituminous coal for about 28 cents per

thousand standard cubic feet, from $2 per ton lignite for about 26 cents per thousand standard cubic feet. Hydrogen costs increase rapidly as maximum helium temperature drops below 2500°F. (auth)

**7953** SOVIETS DEVELOP NEW REACTOR INSTALLATION. Figyelo, No. 37, 8(Sept. 11, 1963).

An installation that will emit neutron-free gamma radiation after an indium-gallium alloy is bombarded with neutrons was developed. A high capacity nuclear reactor, equipped with such an installation, may be used to prepare various chemical starting materials, especially synthetics. With this installation, it is also possible to refine petroleum by cracking. (TCO)

**7954** FUTURE POSSIBILITIES AND EFFICIENCY QUESTIONS FOR ATOMIC-POWER-HEATING-PLANTS. J. Halzl. Prakt. Energiek., 11: 21-5(1963). (In German)

The heat-consumption of industry accounts for more than one-third of the total basic energy consumption of Hungary. It can be stated further that in most countries more basic energy is required for the production of industrial process-heat than for the generation of electricity. Accordingly it would be of great significance from the point of view of energy economy if parallel to the development of nuclear plants for electricity generation, nuclear heat-producing plants could be made competitive with conventional systems. The expected economy of nuclear heat-producing plants largely depends on the trend in the capital costs of small reactors and varies according to certain peculiar characteristics of the heat-consumer, such as temperature requirement, maximum heat demand and load-factor. Roughly one half of the total heat-requirement of industry is to be left out of consideration due to the temperature limitations in present technology reactors. In the foreseeable future, therefore, the chances of nuclear heat-reactors are restricted to the consumers of process-steam and only to the larger plants with high load-factors. Although the permissible specific investment costs arrived at are higher than the actual costs of nuclear plants of equal output, further development work can lead to the reduction of the costs of nuclear heat. A brief survey of world progress in the development of heat-producing nuclear plants is given. (auth)

## Production Reactors

**7955** (HW-78962(p.6.20-4)) N-REACTOR PRESSURE TUBES. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Construction of the facility for the mechanical testing of N-Reactor, PRTR, and KE-Reactor irradiated tubing sections is continuing on schedule; completion will be early 1964. The service life expectancy of N-Reactor Steam Generator tubes having defects through as much as 80% of their wall is being evaluated in an accelerated test. Twenty-five tube sections undergoing stress rupture tests are periodically examined nondestructively to determine if the defects have changed size. Brittle fracture tests were made on N-Reactor pressure tubes covering a range of crack lengths. Within the precision of the testing method the hoop stress at failure appeared inversely proportional to the square root of crack length. This was in agreement with crack propagation theory. Crack speed was measured electronically at 84,000 cm/sec (2750 ft/sec) as compared with 64,200 cm/sec (2100 ft/sec) estimated from high speed photographs. (auth)

## Propulsion and Space

**7956** (GA-3992(Pt.I)) THERMIONIC SPACE POWER REACTOR SYSTEM RESEARCH AND DEVELOPMENT. Quarterly Progress Report, November 1, 1962–January 31, 1963. J. T. Ream, Jr., R. S. Stone, and A. F. Weinberg (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Feb. 28, 1963. Contract AT(04-3)-167. 30p.

Attention is given to vacuum testing of in-pile and out-of-pile models; development of ceramic fuels and fuel claddings; joining techniques; and thermionic cell design and fabrication studies. (T.F.H.)

**7957** (GEMP-257) 630A. MARITIME NUCLEAR STEAM GENERATOR PROGRESS REPORT NO. 6. (General Electric Co. Advanced Technology Services, Cincinnati). Dec. 31, 1963. Contract AT(40-1)-2847. 111p.

The current status of the 630A nuclear steam generator program is given. Information is included on the propulsion system, reactor, shield plug, pressure vessel, boiler, controls, primary coolant system, associated test equipment, auxiliary cooling system, critical experiment test operations, handling equipment, facilities and equipment, fuel materials, and safety analysis. (N.W.R.)

**7958** (JPL-TR-32-441) FUEL-CONTAINMENT REQUIREMENTS FOR GASEOUS-FUEL NUCLEAR ROCKETS. Robert V. Meghreblian (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Sept. 2, 1963. Contract NAS 7-100. 13p.

Fuel-containment requirements for open-cycle gaseous-fuel nuclear rockets are examined for systems in which there is physical contact between propellant and fuel. Such systems necessarily allow some loss of nuclear material. Analysis shows that the total fuel lost during the propulsion period is the prime constraint in determining containment requirements. A parameter, the containment factor, is introduced to provide a measure of fuel-containment efficiency. Application to representative high-thrust (booster) and low-thrust (interplanetary) vehicles is considered. The analysis indicates that containment factors fifty times as large as those presently demonstrated experimentally are required, in order to limit nuclear fuel loss during propulsion to the order of 1000 kg. (auth)

**7959** (NP-13478) A STUDY OF NUCLEAR ELECTRIC AND NUCLEAR ROCKET SPACE PROPULSION. Report B-110053-3. T. N. Edelbaum (United Aircraft Corp., East Hartford, Conn.). June 1963. 18p.

The future of nuclear space propulsion is examined by considering the applicability of both solid-core nuclear rockets and electric propulsion systems to both manned and unmanned missions. Brief consideration is also given to the gaseous-core nuclear rocket. The mission performance of these systems is compared; and the growth potential, the development cost, and the additional applications of each system are discussed. The funding history of both nuclear rocket and nuclear electric programs is reviewed, and the current thinking in various NASA centers concerning these systems is discussed. (auth)

**7960** BOILING POTASSIUM REACTOR FOR SPACE. A. P. Fraas (Oak Ridge National Lab., Tenn.). Nucleonics, 22: No. 1, 72; 74(Jan. 1964).

The development of a boiling potassium-cooled, stainless-steel reactor is discussed. The objective of the program is to provide an advanced, single-loop, nuclear-powered system with an output in the range from 100 to 300 kw(e). It is

believed that the stainless steel system will give a specific weight of ~30 lb/kw(e) with reactor temperatures of ~1500–1600 F. The choice of potassium over Cs or Rb is discussed, and physical properties of K and $H_2O$ compared for typical boiler conditions are tabulated. (P.C.H.)

**7961** SCHEME OF RULES FOR THE CONSTRUCTION OF NUCLEAR SHIPS. F. Spinelli and A. De. Biase. Tec. Ital., 28: 96(Mar. 1963). (In Italian)

A summary and discussion of provisional rules for nuclear-propelled ships issued by Lloyd's Register, Det Norske Veritas, the Bureau Veritas, and the American Bureau of Shipping are presented. Some differences in scope between the rules required for nuclear ships and those for conventional ships are pointed out. Proposals for a set of rules are then given. (auth)

**7962** SHIP MOTION EFFECTS ON BOILING WATER REACTOR DYNAMICS. G. L. West, Jr., and Hideaki Nishihara (Univ. of Michigan, Ann Arbor). New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-244, 8p, $1.00. (CONF-102-24)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

The dynamic behavior of a natural-circulation boiling water reactor has been studied under varying gravitational field conditions. An analytical model has been used with modifications. The numerical values of constants and parameters are based on the Experimental Boiling Water Reactor. Sinusoidal variations in gravity and an actual heave data taken from a ship record have been used as the inputs. The result shows no extreme resonance peaks in the frequency range of 0.1 to 10.0 rad/sec. Responses owing to actual ship motion are as expected by the response data owing to sinusoidal variations in g. (auth)

**7963** NS SAVANNAH OPERATING EXPERIENCE. J. H. MacMillan (Babcock and Wilcox Co., Lynchburg, Va.). D. C. MacMillan, J. E. Robb, H. I. Lill, Jr., and R. O. Mehann. 34p. (CONF-318-1)

From the Society of Naval Architects and Marine Engineers Annual Meeting, New York, Nov. 1963.

A comprehensive summary of the total NS Savannah program with particular emphasis on the test and operational performance of the ship and its nuclear propulsion system is presented. A discussion is presented on the future role of nuclear ships that will follow in the wake of the Savannah. Primary emphasis is placed on the technical aspects of the ship and nuclear power plant performance, maintenance experience, and proposed modifications that have resulted from the first year's operating experience. (auth)

**7964** NUCLEAR-THERMOELECTRIC SPACE POWER SYSTEM. E. S. Pedersen (Martin Co., Orlando, Fla.). Paper 3.3.4 of "Technical Papers." North Hollywood, Calif., Western Periodicals Co., 1963. 5p.

A thermoelectric conversion system that uses a nuclear reactor as a heat source is described. The converter and the waste-heat radiator form an integral part, and the system makes use of two liquid-metal loops and a heat exchanger to match the characteristics of a nuclear reactor to those of the thermoelectric generator. A thermoelectric-electromagnetic pump provides a means of circulating the liquid metals in both loops. The operating temperatures of the thermoelectric materials used in the design are conservative, permitting a lifetime expectancy of several years. (auth)

## Research and Test Reactors

*Refer also to abstract 7684.*

**7965** (HW-78491) EVALUATION OF CONTAINMENT VESSEL PENETRATIONS AT THE PLUTONIUM RECYCLE TEST REACTOR. R. G. Clark (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1, 1963. Contract AT(45-1)-1350. 9p.

One penetration used for pneumatic instrument lines and sealed with an epoxy resin failed during the leak test. The hardened cap of potting material on this penetration was dislodged, and viscous resin poured out of the penetration dish onto the floor leaving a large hole through which air from the vessel escaped. Subsequent analysis revealed that the most probable cause of the failure of the resin to harden throughout the panlike penetration was incorrect mixing of the resin and the catalyst. This penetration was completely repoured and successfully retested. Several minor leaks were found during the testing. These were repaired and also retested successfully. Detectable leakage from two 6-inch vacuum relief lines on the vessel wall was estimated and accepted because of their small contribution to an overall permissible (1000 $ft^3$/24 hr) leak rate. The overall leak rate from penetrations after repairs were completed was estimated to be less than 200 $ft^3$/day with the vessel pressurized to $2\frac{1}{2}$ psig. (auth)

**7966** (IDO-16707) CONCEPTUAL DESIGN OF A GAS-COOLED LOOP FOR THE ATR. D. R. deBoisblanc, W. C. Francis, and L. H. Jones, eds. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). July 31, 1961. Contract AT(10-1)-205. 23p.

Results are presented of a conceptual design study for a gas-cooled loop to be inserted in one of the outer test facilities in the Advanced Test Reactor. The design objectives called for a circulating gas loop capable of operation in a maximum fast neutron flux of $1.3 \times 10^{15}$ n/$cm^2$/sec with an associated gamma heat of 22 watts/gram. The maximum temperature of the gas would be 1400°F. The loop proposed was designed for air cooling; other gases such as $N_2$ or He may also be used but with some changes in the operating parameters. One pound per second of air at 250 psi and 200°F is circulated in a 4-in. OD (2.5-in. ID) top reentrant loop capable of removing 225 kw of fission plus gamma heat from a test specimen. The maximum outlet gas temperature with fission heat is 1400°F; without fission heat it is 900°F. Constructed primarily of 347 stainless steel with 304 stainless steel in some out-of-pile regions, the proposed loop is estimated to cost $720,000 including design and contingencies. Time required for engineering, procurement, fabrication, and installation is estimated to be twelve to fifteen months. (auth)

**7967** (ORNL-3529) MOLTEN-SALT REACTOR PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING JULY 31, 1963. (Oak Ridge National Lab., Tenn.). Jan. 7, 1964. Contract W-7405-eng-26. 157p.

Progress is reported in two separate abstracts: MSRE design, engineering analysis, and component development; and material studies. (N.W.R.)

*For abstracts of individual sections see: 7129 and 7968.*

**7968** (ORNL-3529(p.3-67)) MSRE DESIGN, ENGINEERING ANALYSIS, AND COMPONENT DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

The design, engineering analysis, and component development programs for the Molten Salt Reactor Experiment

are investigated with respect to progress being made. Information is presented on design status, fabrication of major reactor components, major procurement, construction status, instrumentation, component development, engineering test loop operation and evaluations, maintenance development, and reactor characteristics. (N.W.R.)

**7969** (TID-19910) STATUS REPORT OF NORA PROJECT. (Norway. Institutt for Atomenergi, Kjeller). Sept. 15, 1963. Contract AT(30-1)-2760. 15p. (NC-49)

The development and operation of the Norwegian reactors (NORA, JEEP II, JEEPNIK, and HALDEN) are summarized along with research activities associated with the reactors. Information is given on fuel development, measurements on $D_2O/H_2O$ moderated systems, buckling measurements, macroscopic flux measurements, intracell thermal neutron flux measurements, temperature and water level coefficients, void measurements, reactor kinetics, and experimental equipment development. (N.W.R.)

**7970** (TID-19911) QUARTERLY REPORT OF NORA PROJECT, FEBRUARY 15–MAY 15, 1963. (Norway. Institutt for Atomenergi, Kjeller). Contract AT(30-1)-2760. 9p. (NC-48)

The operation of NORA research reactor is summarized along with experimental and theoretical activities associated with the reactor. Information is given on void effects in $D_2O$ and $H_2O/D_2O$ moderated lattices, buckling measurements using substitution experiments, microscopic parameters, multigroup neutron spectrum and criticality code BIGG, and K-7 multigroup thermalization code. (N.W.R.)

**7971** (VDIT-80) RESEARCH REACTOR DATA FOR ETR, MTR, GETR AND ORR. A Literature Survey. A. Nystroen (Aktiebolaget Atomenergi, Studsvik, Sweden). Nov. 1963. 43p.

Presented are 91 abstracts concerning operating characteristics and nuclear and heat transfer data for a comparative study of an improved reactor operation economy in research reactors. The references include one early published bibliography covering the period 1952 through 1958. For this survey abstracts were gathered from the following subject headings: Engineering Test Reactor; General Electric Test Reactor; Materials Testing Reactor; and ORNL Research Reactor, from Nuclear Science Abstracts 1957 through September 1963. The abstracts are arranged under subject headings with subdivision for ETR, MTR, GETR, and ORR. The headings are: Specific power; Core heat transfer; Fuel element heat transfer; Fuel element surface temperature; Neutron flux; Core structure materials; Coolant flow per fuel element; Coolant temperature and coolant pressure; Shut down heat removal; Development for reduction of operating costs; and Miscellaneous. (auth)

**7972** PRODUCTION OF RADIOACTIVE ISOTOPES IN THE FIRST HUNGARIAN EXPERIMENTAL ATOMIC REACTOR. Istvan Kiss and Peter Gröz. Energia Atomtech., 16: 407-14(Sept. 1963). (In Hungarian)

**7973** THE INVESTIGATION OF HYDRODYNAMIC AND THERMAL CHARACTERISTICS OF THE VVR-S NUCLEAR REACTOR. Vladimír Zajíc (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Řež). Jaderna Energie, 9: 347-52(Nov. 1963). (In Czech)

The method and results of measurements of water flow, hydraulic resistance, and heat flow in the cooling system of the reactor are described. Hydrodynamic behavior in the active core of the reactor was evaluated. The investigation serves as a base for a prepared power increase of the VVR-S reactor. (auth)

**7974** ANALYSIS OF THE MAXIMUM CREDIBLE INCIDENT FOR A REACTOR OF THE PARTIALLY CONTAINED SWIMMING POOL TYPE. Aldo Cuoco, Remo Galvagni, and Roberto Scafe (Comitato Nazionale per l'Energia Nucleare, Ispra, Italy). Riv. Ing. Nucl., 1: 109-28(May-June 1963). (In Italian)

An analysis of the order of magnitude of the maximum possible incident and of the consequences for a swimming pool reactor is presented. The Forbes and Corben theory is used with the adoption of approximate theories derived from preceding experience. The two incidents discussed are loss of the water in the pool and a nuclear excursion. The factors of meteorological dispersion and the release of fission products are considered in the analysis. (J.S.R.)

**7975** EXPERIMENTAL IRRADIATION APPARATUS FOR A SWIMMING POOL TYPE NUCLEAR REACTOR. Victor Raievski (to Commissariat a l'Energie Atomique). British Patent 944,049. Dec. 11, 1963. Priority date May 20, 1960, France.

A loop apparatus is designed for irradiation experiments in a swimming-pool reactor. The apparatus comprises a portion for immersion in the pool and a portion for location outside the pool. The immersed portion includes a tube assembly for test specimens to be irradiated and means for circulating a fluid along the tube in a closed circuit. The outside portion includes means for controlling the pressure and measuring the activity of the fluid in the immersed portion, and flexible detachable lines are provided for connecting the two portions. (D.L.C.)

**7976** IMPROVEMENTS IN NUCLEAR REACTORS. (to European Atomic Energy Community (EURATOM)). British Patent 944,500. Dec. 18, 1963. Priority date Sept. 15, 1961, Belgium.

An improved neutron absorption shield for test reactors is designed which may be used for geometric buckling and open-core measurements. The shield comprises an upright tube which is constructed of section, each like a roller shutter which can be lowered or raised. A rigid tube may be attached to the lower end of the adjustable tube. (D.L.C.)

**7977** IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Boris Barabach, Jacques Berger, Gerard Dupuy, Jean Lacour, and Victor Raievski (Commissariat a l'Energie Atomique). British Patent 946,336. Jan. 8, 1964. Priority date May 20, 1960, France.

A swimming pool reactor for neutron irradiations was designed so that the core and related members are located at the center of the pool and self-contained testing loops are disposed around the core assembly. The inlet and outlet pipes for the cooling water are so sited as to allow easy manipulation of the loops. These pipes are provided with deflection vanes. The irradiation loops are protected against heating by gamma radiation from the core by lead screens which are relatively transparent to neutrons surrounding the core assembly and provided with cooling water circulation. (M.C.G.)

**7978** NUCLEAR REACTOR INSTALLATION. (to General Dynamics Corp.). French Patent 1,314,188. Nov. 26, 1962. Priority date Jan. 30, 1961, United States.

A nuclear reactor installation comprises a pool filled with a cooling liquid, a reactor core adapted to occupy at least two working positions within that pool, and means for displacing the core between these working positions.

Preferably the poolwall shows, at two opposite extremities, two bulges enclosing semicylindrical cavities that constitute the places of the working positions. The means for displacing the core comprises a carriage rolling on rails mounted in the space above the pool and supporting the core. A movable radiation shield is disposed within the pool adapted to separate the two working places and is suitably constituted of two rotating doors such as to form, in their open position, a passage for the reactor core. Two irradiation chambers are arranged outside the pool adjacent to the pool wall so that each of the bulges reaches into a corresponding irradiation chamber. (IIB)

# WASTE DISPOSAL AND PROCESSING

*Refer also to abstracts 6883 and 7950.*

**7979** (HW-79174) PROGRESS IN TREATMENT OF A RADIOACTIVE CONDENSATE WASTE. J. M. Skarpelos (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1963. Contract AT(45-1)-1350. 80p.

A waste stream decontamination process based on ion exchange was selected for development. The process is centered on ion-exchange technology developed during recent years in the Hanford Laboratories and other atomic energy research centers. Early attempts at small engineering scale application of ion-exchange technology resulted in less than satisfactory results when compared to laboratory data. The difficulties were traced to nonradioactive impurities in the wastes. Steam stripping and filtering successfully removed these impurities, and excellent decontamination of all significant isotopes except ruthenium was achieved by ion exchange. Satisfactory ruthenium decontamination was demonstrated on waste volumes up to about 1000 column volumes, and the capacity for other isotopes ranged from 10,000 to 20,000 column volumes. Improvement in ruthenium decontamination is needed to simplify operations and to improve economics. Although a large-scale integrated process is yet to be demonstrated, a cost estimate of an ion-exchange process was made. The estimate of $7.50/1000 gal was based on a 2 ton/day fuels reprocessing plant which produces about 30,000 gal/day of condensate requiring treatment. The estimate was based on a process for alkaline condensate and it was assumed a process for acid condensate would cost about the same. This estimate is about $10/1000 gal less than the estimated cost for reevaporation. (auth)

**7980** (HW-SA-3279) THE MANAGEMENT OF HIGH-LEVEL RADIOACTIVE WASTES. Allison M. Platt (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 14, 1963. Contract AT(45-1)-1350. 19p.

A survey is presented of current practices of USAEC and its contractors for managing high-level radioactive wastes. The future waste problems associated with a growing nuclear power industry are discussed, and the progress of research and development activities on solidification of wastes is summarized. (D.L.C.)

**7981** (ORNL-TM-715) ENGINEERING STUDIES ON POT CALCINATION FOR ULTIMATE DISPOSAL OF NUCLEAR WASTE: FORMALDEHYDE-TREATED PUREX WASTE FOR 1965 (FTW-65). C. W. Hancher, J. C. Suddath, and M. E. Whatley (Oak Ridge National Lab., Tenn.). Jan. 6, 1964. Contract W-7405-eng-26. 182p.

Nine continuous evaporator-calciner tests were made with simulated formaldehyde-treated Purex waste (FTW-65). The average processing rate was 40 liters per hour. The calcined solids had an average bulk density of 1.27 g/cc and a residual nitrate concentration of 100 to 400 ppm. The overall decontamination factor was about 7,000 for non-volatile ions such as iron, 3,000 for ruthenium, 1,400 for sulfate, and 17 for mercury. Attempts to trap the mercury in the calciner off-gas were not successful. Control of the close-coupled evaporator and calciner was generally good. Processing waste containing degradation products of tributylphosphate caused some control difficulties because of foaming. Severe corrosion of the calciner occurred when fluoride was present in the feed. Continuous addition of calcium nitrate in proportion to the feed rate improved the sulfate decontamination. An attempt to produce a glass failed because of foaming and plugging of the calciner off-gas line. (auth)

**7982** (ORNL-TM-734) DEMONSTRATION DISPOSAL OF HIGH-LEVEL RADIOACTIVE SOLIDS IN LYONS, KANSAS, SALT MINE: BACKGROUND AND PRELIMINARY DESIGN OF EXPERIMENTAL ASPECTS. R. L. Bradshaw, J. J. Perona, and J. O. Blomeke (Oak Ridge National Lab., Tenn.). Jan. 10, 1964. Contract W-7405-eng-26. 41p.

A demonstration of the disposal of high-level radioactive waste solids to be carried out in a salt mine at Lyons, Kansas, will have as its objectives: (1) the demonstration of required waste-handling equipment and techniques, (2) the determination of the stability of salt under the influence of heat and radiation, and (3) the collection of information on creep and plastic flow of salt which is needed for the design of an actual disposal facility. As presently conceived, 14 irradiated fuel assemblies from the Engineering Test Reactor will serve as a source of radiation in lieu of actual solidified wastes. The assemblies will be placed in a circular array of holes in the floor with one can in the center and other six cans located peripherally, spaced 5 ft on centers. During the course of the 2-year test, four sets of assemblies will be used to achieve a peak dose to the salt of about $8 \times 10^8$ rad and the temperature of the adjacent salt will be maintained at 200°C with electrical heaters. A second array, consisting only of heaters, will be operated as a control to determine those effects due solely to heat. In addition to the radioactive and control arrays, a rib-pillar located between the two arrays will be heated electrically around its base to produce significant information on salt flow characteristics at elevated temperatures. (auth)

**7983** DISPOSAL OF EFFLUENTS CONTAMINATED WITH RADIOACTIVE SUBSTANCES. A. T. Avdonin. Gigiena i Sanit., 28: No. 8, 14-19(1963).

Problems connected with the disposal of effluents from various enterprises dealing with open radioactive substances are discussed. Data are presented on the quantity and degree of effluent contamination and on the method of determining the extent of effluent decontamination required before its discharge into the sewerage system or a water basin. The choice of methods of effluent decontamination are discussed, and a short description and assessment of various decontamination methods is given. (Public Health Eng. Abstr., 43: Dec. 1963)

**7984** METHOD AND MATERIALS FOR DISPOSING OF RADIOACTIVE WASTE. Henry P. Beerman (to Victor Comptometer Corp.). U. S. Patent 3,116,131. Dec. 31, 1963. Filed Aug. 1, 1960.

A method is given for isolating radioactive wastes contained in waters or vapors. The method comprises impregnating the wastes into granules or pellets of fusible, absorbent ceramic material by absorption, adsorption, or capillary condensation; drying the granules; and heating the granules to glaze or fuse their exterior surfaces into a continuous vitreous film that prevents leaching of the

trapped wastes. The ceramic material comprises two major components, 80 to 90% of expanded cellular mineral absorbent (vermiculite, obsidian, pitchstone, pumice, etc.) and 10 to 20% of a fusible bonding material (bentonite, kaolin, etc.). Also, 10 to 25% of a desiccant (calcium oxide, magnesium oxide, etc.) may be used to permit capillary condensation of wastes entrained in a vapor. A method is given for making the ceramic material. (D.L.C.)

# GENERAL AND MISCELLANEOUS

**7985** (BMI-1650(Del.)) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING SEPTEMBER 1963. Russell W. Dayton and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). Oct. 1, 1963. Contract W-7405-eng-92. 67p.

Progress is reported for projects in the following areas: reactor materials and components, fuel development, radiation applications in polymerizations, tracer system for in-place filter evaluation, development of coated-particle fuels, corrosion in fluoride-volatility process, mechanical properties of SAP and Zr alloys, fission product deposition, $UO_2$–$ZrO_2$ studies, postirradiation examination of Hastelloy X cladding, and joining of regenerative cell components. (D.L.C.)

**7986** (BNL-806) ANNUAL REPORT, JULY 1, 1963. (Brookhaven National Lab., Upton, N. Y.). Contract AT-30-2-GEN-16. 208p.

Developments and research programs are abstracted in three separate sections: physical sciences and engineering, life sciences, and supporting activities. Information is also presented on the organization, finances, publications, service, research facilities, and administration. Separate abstracts were prepared for the three sections. (N.W.R.)

*For abstracts of individual sections see: 6586, 7987, and 7988.*

**7987** (BNL-806(p.3-90)) PHYSICAL SCIENCES AND ENGINEERING. (Brookhaven National Lab., Upton, N. Y.).

Research and development activities at Brookhaven in the fields of physics, chemistry, instrumentation, nuclear engineering, mathematics, metallurgy, and meteorology are summarized. Information is included on reactors, accelerators, computers, waste disposal, particle physics, nuclear structure, neutron physics, atomic and molecular physics, solid state physics, radiation chemistry, isotope production and development, nuclear properties and reactions, organic chemistry, cosmochemistry, inorganic chemistry, physical chemistry, and radiation processing research and development. (N.W.R.)

**7988** (BNL-806(p.125-47)) SUPPORTING ACTIVITIES. (Brookhaven National Lab., Upton, N. Y.).

The technical services, facilities, administration, and operations essential to the research programs at the Laboratory are discussed. Information is provided on reactor operations, hot laboratory operations, health physics, mechanical engineering, machine shops, technical information, photography and graphic arts, construction, security and plant protection, plant maintenance, personnel, business management, conferences and public information, irradiation services, isotope production, waste disposal, and safety. (N.W.R.)

**7989** (BNL-7394) MANGANESE POISONING—NEW INSIGHTS. George C. Cotzias and Melvin H. Van Woert (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 21p. (CONF-172-1)

From 1st Panamerican Congress of Neurology, Lima, Oct. 1963.

Manganese poisoning is discussed as being a clinical model in the study of extrapyramidal disorders. Various technical developments are mentioned which have extended our capabilities for investigating the metabolism of Mn. Some observations are presented on the normal physiology of this element and on some distortions thereof. The high concentration of Mn in malanin granules was noted. These bodies were proposed as possibly reflecting chemical and physical changes underlying some extrapyramidal diseases including Mn poisoning. (auth)

**7990** (BNL-7441) LIGHT-DRIVEN CYTOCHROME REACTIONS IN ANACYSTIS AND EUGLENA. John M. Olson and Robert M. Smillie (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT-30-2-GEN-16. 18p. (CONF-317-2)

From Proceedings of Symposium on Photosynthesis of Green Plants, Airlie, Va., Oct. 1963.

The basic cytochrome physiology of Anacystis nidulans and Euglena gracilis is compared. Emphasis is placed on basic similarity in view of gross dissimilarities in size, structure, and pigment content. Results are reported from a spectrophotometric investigation of cytochrome reactions and patterns of energy transfer from light receptors to the reaction centers involved in photochemical reactions during photosynthesis in these organisms. The pathways of photosynthetic electron transfer were also studied under varied wavelengths and intensity of monochromatic actinic light. Some preliminary observations are included on the effect of carbonyl cyanide m-chlorophenylhydrazone. The reduction of cytochrome in Euglena chloroplast fragments is described. (C.H.)

**7991** (BNL-7448) FAST ANALOGUE MULTIPLIERS WITH FIELD-EFFECT TRANSISTORS. V. Radeka (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 12p. (CONF-363-6)

From International Symposium on Plasma Phenomena, San Diego, Calif., Oct. 1963.

The solution time of analog multipliers using field-effect transistors is investigated. This time is ultimately limited by the charging time of the transistor junction. In typical devices suitable for analog multiplication, the charging time is found to be about 10 to 20 nsec for a multiplication error of $< 1\%$. A four quadrant pulse amplitude multiplier circuit with a solution time equal to the transistor charging time is described. (auth)

**7992** (BNL-7475) STUDIES OF THE LOCALIZATION, PHYSICOCHEMICAL PROPERTIES, AND ACTION OF PHYCOCYANIN IN ANACYSTIS NIDULANS. John A. Bergeron (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT-30-2-GEN-16. 16p. (CONF-317-3)

From Proceedings of Symposium on Photosynthesis of Green Plants, Airlie, Va., Oct. 1963.

Results are reported from studies of photosynthesis in the blue-green algae Anacystis nidulans. Emphasis was placed on the properties and action of phycocyanin in light absorption. (C.H.)

**7993** (CONF-355-2) MAGNESIUM TURNOVER IN MAN. Jerry K. Aikawa (Colorado. Univ., Denver. School of Medicine). [1963]. Contract AT(11-1)-282. 27p.

From Symposium in Medicine, Dynamic Clinical Studies with Radioisotopes, Oak Ridge, Tenn., Oct. 1963.

Data are reviewed from a number of studies on the metabolism of Mg in man and the role of Mg in biological processes. Results are reported from studies using $Mg^{28}$ as a tracer of Mg metabolism in laboratory animals and in man in health and various disease states. It is postulated that the role of Mg in many vital processes may be ex-

plained by the fact that the Mg ion tends to form hydrates and double salts and hence has the capacity for complex formation. (C.H.)

**7994** (GTR-21) FUNDAMENTALS OF DIFFUSIONAL BONDING. [PART] VIII. Final Progress Report, July 1, 1962–June 30, 1963. L. S. Castleman and L. Seigle (General Telephone and Electronics Labs. Inc., Bayside, N. Y.). Dec. 15, 1963. Contract AT(30-1)-2102. 60p.

A study was undertaken of interdiffusion in the copper–zinc–nickel system. The identity and sequence of appearance of the intermediate phases found in the diffusion zone were determined by correlation of metallographic observations of microstructure with details of the equilibrium phase diagram and with electron-beam-probe microanalysis. It was found that all except possibly one of the intermediate layers growing in the diffusion zones of the diffusion couples investigated consisted of single phases. In some of the couples the concentration of zinc did not vary monotonically with distance. The sequence of phases in the diffusion couples was independent of time at each temperature. The diffusion paths for couples having the same component as one terminus and a binary alloy of the remaining two components as the other terminus did not appear to cross. The tangent to the diffusion path in the vicinity of the terminal compositions tended to orient itself so that the angle between it and the lines radiating from the apex of the fastest diffusing component was small. In general, the results corroborated many of the observations and conclusions of Clark and Rhines for the aluminum–magnesium–zinc system. (auth)

**7995** (KR-60) QUARTERLY PROGRESS REPORT, JULY–SEPTEMBER 1963. (Norway. Institutt for Atomenergi, Kjeller). Nov. 1963. 40p.

Operation and development of reactors and nuclear processes in Norway are reviewed. Information is given on the operation of JEEP and NORA reactors, development of JEEP II, fuel element development for Halden Boiling Reactor, neutron diffraction analysis of $Fe_7Se_8$, buckling of $D_2O/H_2O$ moderated lattices, reactor dynamics, hydrodynamics, reactor physics calculations, marine boiling reactor development, fuel element fabrication, fuel processing, brazing, welding, corrosion of fuel element materials, fabrication and properties of fuel element materials, plutonium purification, ruthenium chemistry, amine extraction systems, water analysis, chemical analysis, isotope production and development, and reactor operator training. (N.W.R.)

**7996** (NP-13476) REPORT ON THE ACTIVITIES OF THE DANISH ATOMIC ENERGY COMMISSION, APRIL 1, 1962–MARCH 31, 1963. (Denmark. Atomenergikommissionen, Roskilde). Oct. 1963. 84p.

The research and development activities of the Danish Atomic Energy Commission are summarized. Information is reported on reactor physics, physics, electronics, research reactors, chemistry, construction, health physics, metallurgy, geology, linear accelerator, radiobiology, agriculture, radiation chemistry, international and local co-operation, education and training, general information services, technical and administrative organization, and finances. (N.W.R.)

**7997** (SC-4967-(RR)) A PLANE-WAVE EXPLOSIVE SYSTEM FOR THE GENERATION OF LOW-AMPLITUDE SHOCK WAVES IN SOLIDS. W. B. Benedick (Sandia Lab., Albuquerque, N. Mex.). Dec. 1963. Contract AT(29-1)-789. 36p.

An explosive system using nitroguanidine to reproducibly generate a low-amplitude plane shock wave in a solid material is described. The detonation pressure of the nitroguanidine compact at 0.3 gm/cc is included. Detailed techniques for making the explosive lens and compact assembly are given. (auth)

**7998** (SC-DC-3563) A MONOPOLE ANTENNA DRIVEN WITH RESPECT TO A SMALL DISC. Quarterly Progress Report. Richard H. Williams and Calvin W. Thomas (New Mexico. Univ., Albuquerque. Coll. of Engineering). Oct. 1963. For Sandia Corp., Albuquerque, N. Mex. Contract AT(29-1)-789. 15p.

Relations were derived for expressing the radiated fields of the monopole as a function of the current in the monopole and in both sides of the disc. (D.C.W.)

**7999** (SC-DC-3567) REFLECTION OF A PULSE OF PLANE ELECTROMAGNETIC RADIATION FROM A FLAT EARTH. (New Mexico Coll. of Agriculture and Mechanic Arts, State College. Physical Science Lab.). [Nov. 1963]. Contract [AT(29-1)-789]. 13p.

The possibility of radar pulse distortion during the reflection process is examined. It is concluded that within the range of applicability of the usual equations of electromagnetic theory there will be no pulse distortion for the range of carrier frequencies and pulse durations presently considered. However, the usual equations of electromagnetic theory are obtained under assumptions that are inconsistent with actual radar reflection. (D.C.W.)

**8000** (SC-R-742) A METHOD OF PROCESS IDENTIFICATION OF CERTAIN LINEAR CONTROL SYSTEMS. E. A. Aronson (Sandia Corp., Albuquerque, N. Mex.). Dec. 1963. 107p.

In the case of a linear-lumped control system with slowly changing performance characteristic, the process identification problem can be solved by evaluating, as functions of time, the coefficients of the polynomials that constitute the transfer function of the undetermined control system. A method of estimating these coefficients is described; and its advantages and limitations are discussed. The technique applies only to linear-lumped control systems whose zeros are known, and hence estimates only the poles of the system. The accuracy of the estimation in the presence of noise is discussed. In particular, techniques are evolved to enable choice of the fixed systems to lessen any error in the estimation due to noise. Expressions are evolved for error estimation with gaussian noise and signals. Techniques are also discussed that further lessen the errors in the estimations once the fixed systems have been chosen. Finally, a computer simulation of the estimation method is presented for a few simple cases. Conclusions drawn from the simulation indicate that the method does indeed measure the unknown parameter and yield good results for reasonable noise levels. The simulation also corroborates the error reduction techniques previously discussed. (auth)

**8001** (SC-TM-164-57(51)) A METHOD TO PREDICT THE INDUCED FLOW AROUND AXIALLY SYMMETRIC JETS. F. G. Blottner (Sandia Corp., Albuquerque, N. Mex.). July 26, 1957. Contract AT(29-1)-789. 19p.

The method uses a distribution of line sinks, the sink strength of which is a function of the rate that mass is being added to the jet, which is determined from experimental results. (auth)

**8002** (SC-TM-258-63(73)) THE PSYCHROMETER, MODEL II. J. I. Poore (Sandia Lab., Albuquerque, N. Mex.). Sept. 1963. Contract AT(29-1)-789. 34p.

The psychrometer measures percentage of relative humidity and temperature. The relative humidity can be

measured to an accuracy better than 1 per cent over the range from 5 to 98 percent in a temperature range of 35°F through 140°F. A test report on this psychrometer by the National Bureau of Standards is given. The psychrometer will measure temperature with an accuracy within 0.05°F over the range 32°F through 212°F. The operation theory, general description, and operating procedures are included. (auth)

**8003** (SC-TM-308-63(74)) NOTE ON VISCOUS LAYER/FREE-STREAM INTERACTION IN AN AXIALLY SYMMETRIC CHANNEL. K. J. Touryan (Sandia Lab., Albuquerque, N. Mex.). Dec. 1963. Contract AT(29-1)-789. 12p.

A brief analysis is made to determine the displacement effect of the boundary layer on an inviscid axially symmetric flow using the momentum integral approach. An adjustment is made in the velocity profile to account for slip effects. (auth)

**8004** (TEI-842) OUTLINE OF THE GEOLOGY OF THE U12i AND U12i.01 TUNNELS AND LITHOLOGY OF THE U12i.01 DRILL HOLE, NEVADA TEST SITE. W. E. Bowers (Geological Survey, Washington, D. C.). Nov. 1963. 41p.

Data on the geology of the U12i and U12i.01 tunnels and lithology of the U12i.01 drill hole at the Nevada Test Site are presented in tables, graphs, and maps. (M.C.G.)

**8005** (TEI-843) GEOLOGY OF JACKASS FLATS QUADRANGLE, NEVADA TEST SITE, NEVADA. Edward J. McKay and W. P. Williams (Geology Survey, Washington, D. C.). Dec. 1963. 13p.

**8006** (TID-4025(Rev.1)(Pt.1)(Suppl.2)) TRANSLATION TITLE LIST AND CROSS REFERENCE GUIDE. Frances E. Stratton, ed. (Division of Technical Information Extension, AEC). 247p.

This supplement lists the unclassified translations received by the Division of Technical Information Extension during the period Jan. 1, 1962 to Dec. 31, 1962. Original source and author indexes are included. (D.L.C.)

**8007** (TID-19713) THE ILLINOIS PATTERN RECOGNITION COMPUTER (ILLIAC III). Report No. 148. Bruce H. McCormick (Illinois. Univ., Urbana. Digital Computer Lab.). Aug. 20, 1963. Contract AT(11-1)-1018. 48p. (CONF-348-1)

From 18th Annual ACM National Conference, Denver, May 1963.

The system design of an all-digital computer for visual recognition is described. The design, fabrication, and use of one processor (the Pattern Articulation Unit) of the computer receive detailed treatment. (D.C.W.)

**8008** (TID-19817) THE KINETICS OF AQUATION OF BROMOPENTAAQUOCHROMIUM(III) ION IN ACIDIC SOLUTION. Frank A. Guthrie and Edward L. King (Colorado. Univ., Boulder). [1962]. Contract AT(11-1)-1286. 10p.

The aquation reaction $Cr(OH_2)_5Br^{2+} + H_2O \rightarrow Cr(OH_2)_6^{3+} + Br^-$ was investigated at 30, 45, and 60°C in solutions of acidity 0.06 to 1.0 M and constant ionic strength. The rate law was found to be $-(d \ln[CrBr^{2+}]/dt) = k_0 + k_{-1}[H^+]^{-1}$. The results are compared with these for $Cr(NH_3)_5Br^{2+}$. (D.L.C.)

**8009** (TID-19832) PRECIPITATION OF INDIUM 8-HYDROXYQUINALDATE FROM HOMOGENEOUS SOLUTION. J. Paul Jones, Orville E. Hileman, Jr., and Louis Gordon (Case Inst. of Tech., Cleveland). [1963]. Contract AT(11-1)-582. 5p.

The precipitation of indium from homogeneous solution as the 8-hydroxyquinaldate with 8-acetoxyquinaldine as a source reagent provides a satisfactory quantitative procedure with a good separation from lead, calcium, magnesium, and aluminum. (auth)

**8010** (TID-19833) PRECIPITATION OF METAL 8-HYDROXYQUINOLATES FROM HOMOGENEOUS SOLUTION. VII. INDIUM AND GALLIUM. J. P. Jones, O. E. Hileman, Jr., A. Townshend, and Louis Gordon (Case Inst. of Tech., Cleveland). [nd]. Contract AT(11-1)-582. 11p.

The precipitation from homogeneous solution of indium and gallium using 8-acetoxyquinoline was investigated. It was established that the method cannot be recommended for the determination of either metal, although under certain rigorously controlled conditions indium 8-hydroxyquinolate precipitates quantitatively and stoichiometrically. The conventional precipitation of indium 8-hydroxyquinolate was also found to give erroneous analytical results. (auth)

**8011** (TID-19834) SOME DATA AND OBSERVATIONS ABOUT AN INTERESTING DREDGE OF MANGANESE NODULES TAKEN IN THE "WESTERN ATLANTIC ABYSSAL-HILLS PROVINCE." Technical Report No. CU-7-63. Mark Salkind (Columbia Univ., Palisades, N. Y. Lamont Geological Observatory). Dec. 1963. Contract AT(30-1)-2663. 18p.

Several photographs, a core, and a bottom dredge were taken from the ocean bottom southeast of Bermuda. The photographs show areas (32°26′ N 62°59′ W) clear of any debris and areas (26°35′ N 56°29′ W) thickly strewn with volcanic debris. The core is described as manganese nodules in soft red clay to 314 cm, followed by an abrupt change to foram ooze and a bottom of volcanic debris mixed with forams and a volcanic rock chunk. The dredge sample obtained at 21°15′ N 56°09′ W was found to be chunks of clay covered with a manganese oxide layer. The outer layer and inner clay body were analyzed separately; the results show the outer layer to be a ferro-manganese-alumino-silicate system which may be considered as a manganese nodule. A possible mechanism for the formation of the outer layer is suggested. No correlation between the composition and that of sea water is apparent. (D.L.C.)

**8012** (TID-19835) DYE-DIFFUSION EXPERIMENTS ON THE GREAT BAHAMA BANK. Technical Report No. CU-6-63. Michael Costin (Columbia Univ., Palisades, N. Y. Lamont Geological Observatory). Dec. 1963. Contract AT(30-1)-2663. 33p.

Two dye diffusion experiments using Rhodamine B were conducted on the north and south portions of the Great Bahama Bank in August 1962. Horizontal diffusion in the shallow tidal areas were studied by ship sampling and aerial photography. The general circulation in the experimental areas is described briefly, and the observed motions and size changes in the dye patches are given. The results show that dye motion is due to tidal currents superimposed on a residual drift dependent on seasonal wind variations. A comparison of the experiments with those conducted off New Jersey is made. (D.L.C.)

**8013** (TID-19840) THRUST MEASUREMENT ANALYSES ON TWO-PHASE FLOW THROUGH APERTURES. Kenneth Chen (Minnesota. Univ., Minneapolis). Nov. 22, 1963. Contract AT(11-1)-926. 10p.

Equations of motion are developed for the case of a fluid flowing across an aperture. The flow of saturated fluid within the pressure vessel is assumed to be the same as that of a single-phase incompressible fluid, although after it leaves the aperture, its flow characteristics are changed.

The calculated and experimental thrusts for saturated water are found to agree, confirming the assumption of no flashing near the aperture within the pressure vessel. (D.L.C.)

**8014** (TID-19844) THE PRIMARY CELL WALL. Progress Report, February 1, 1963 to October 31, 1963. J. E. Varner (Martin-Marietta Corp. Aerospace Div., Baltimore). Contract AT(30-1)-3150. 5p.

Progress is reported in studies of hydroxyproline synthesis in sycamore cells grown in suspensions with and without the addition of $D_2O$. The relation of hydroxyproline to cellulose in cell walls was investigated in suspensions of cells from sycamore and ginkgo cell suspensions. (C.H.)

**8015** (TID-19848) CELL SUSPENSION CULTURES OF HIGHER PLANTS: ISOLATION AND GROWTH ENERGETICS. Derek T. A. Lamport (Cambridge Univ., England). [1962]. Contract AT(30-1)-3150. 29p.

Applications of microbiological techniques in studies of plant metabolism in cell suspensions of higher plants are discussed. Results are reported from studies of sycamore (Acer pseudoplatanus) cell suspensions. The isolation of cells, culture through many generations, and growth characteristics are described. Factors that influence cell clumping are discussed. (C.H.)

**8016** (TID-19851) 1962 PENNSYLVANIA CORN PERFORMANCE STUDIES. Appendix 3. Progress Report 248. (Pennsylvania State Univ., University Park. Coll. of Agriculture). July 1963. 28p.

Data are summarized on the agronomic performance of corn inbreds and hybrids used in field studies in 1962. Most of the data were analyzed with an IBM-7074 computer. Emphasis was placed on inheritance of factors for accumulation of 11 chemical elements, including Sr. (C.H.)

**8017** (TID-19894) REGIONAL BLOOD FLOW MEASUREMENT IN VIVO FOR A DEFINABLE GEOMETRY. Marvin B. Bacaner and James S. Beck (Minnesota. Univ., Minneapolis. Medical School). [1962]. Contract AT(11-1)-1267. 21p.

A radioisotope method for measuring regional blood flow in the intestine of the dog in vivo is compared favorably with measurement by timed collection of total venous outflow. The necessary conditions are a continuous measure of arterial concentration and cumulative regional concentration of radioisotope, and experimentally definable region and temporary complete retention of tracer. The derivation of the relations used suggests additional applications of the method to other regions of the body. (auth)

**8018** (TID-19897) EFFECT OF HYDROSTATIC PRESSURE ON IONIC CONDUCTIVITY IN SODIUM CHLORIDE (thesis). Pascuala Garcia (Columbia Univ., New York. School of Engineering). 1963. Contract AT(30-1)-2921. 16p.

The effect of hydrostatic pressure on the ionic conductivity in polycrystalline sodium chloride was studied. In the temperature range 30 to 200°C and at pressures of 10,000 psi the conductivity is reduced, and the results are similar to those found by Pierce in single crystals. The impurity concentration is probably too high to allow one to see any effect of pressure on grain-boundary conductivity. The reduction in conductivity is believed to be due to a change of the bulk property. The calculated activation energy for the diffusion process is 1.07 ev, practically the same for both stressed and unstressed crystals. (auth)

**8019** (TID-19921) THE BIOLOGICAL ACTIVITIES OF NUCLEIC ACIDS. Annual Progress Report. John S. Colter (Alberta. Univ., Edmonton). Dec. 30, 1963. Contract AT(30-1)-2967. 20p.

Data are summarized from investigations of biological differences in three variants of Mengo encephalomyelitis virus grown on L cells in tissue culture. Differences in rate of attachment to L cells, rate of diffusion through agar, response to pH, and lethal effects in mice are reported for the three variants. Procedures used for electron microscopic examination of the viruses are described. (C.H.)

**8020** (TID-19954) ON THE PARAMETRIZATION OF THE ELASTIC MODULI OF TWO-PHASE MATERIALS. Technical Report No. 4. Tai-Te Wu (Brown Univ., Providence). Oct. 1963. Contract AT(30-1)-2394. 12p.

A single parameter is suggested to account for the complicated stress and strain distributions in two-phase materials. Its existence requires verification from extensive experimental studies. (auth)

**8021** (UCRL-7473) DEFLECTIONS AND STRESSES IN HEMISPHERICAL LIGHTWEIGHT CELLULAR SUPPORT STRUCTURE WITH FLEXIBLE SUPPORTING SHELL. J. Penzien and G. L. Sheldon (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 1963. Contract W-7405-eng-48. 61p.

A spherical component is frequently supported by a hemispherical lightweight cellular core which is in turn supported by a flexible elastic support shell. Design information is given on computing the normal and shear stresses in the core as well as circumferential and meridional stresses in the flexible support shell. A set of graphs is given showing the ratio of these stresses for the case of a flexible support shell to the corresponding maximum stress for the case of a rigid support shell, plotted against the meridional angular coordinate of the hemisphere. Two dimensionless geometrical and material parameters appear as variables in these graphs. A second set of graphs to be used for obtaining displacements of the flexible shell with respect to the supported sphere are also plotted in this manner. For computing the maximum stresses in the shell or core, a graph is given showing the maximum value of the stress ratio plotted against a dimensionless material-geometrical parameter. (auth)

**8022** (UCRL-7517) COMPUTER INFORMATION CENTER. [Chet McIntosh] (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 1963. Contract [W-7405-eng-48]. 59p.

The center will obtain publications of programming and machine manuals pertinent to the laboratory, as well as write-ups of hardware and software systems. Better documentation will be promoted and made available to computer users in the laboratory. The proposed form and content of write-ups for submission to the center are outlined, and the hardware and operations of the center are indicated. (D.C.W.)

**8023** (UCRL-10991) VAPORIZATION OF IRON OXIDES (thesis). Charles A. Washburn (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1963. Contract W-7405-eng-48. 23p.

The vapor species in equilibrium with iron oxide samples of compositions between $FeO_{1.1}$ and $FeO_{1.33}$ were studied with a mass spectrometer in the temperature range 1500 to 1594°C. The molecules O, $O_2$, Fe, and FeO, and only these molecules, were observed over the entire composition and temperature range. The existence of $(FeO)_3(g)$ or $Fe_3O_4(g)$, which was recently claimed from the interpretation of vapor density experiments, appears to have been disproved.

At 1594°C the pressure of FeO(g) in equilibrium with the congruently vaporizing composition is approximately one-third the pressure of Fe(g). (auth)

**8024** (AEC-tr-6236) SELECTION OF A REGRESSION SURFACE FOR THE ADJUSTMENT OF THE INTENSITY OF ILLUMINATION IN AN AIR-CONDITIONING CONTAINER. A. Rotti. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Biometrische Z., 4: 263-73(1962). 12p.

Measurements of the illumination intensities in an air and light conditioned container showed that the intensities were not uniform. An attempt was made to develop regression surfaces that would permit a satisfactory assembly of illumination devices. (D.C.W.)

**8025** (AEC-tr-6241) THE SURFACE-TENSION OF REFRIGERANTS, OF LUBRICANTS AND OF THEIR MIXTURES. H. Steinle. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Kaeltetechnik, 12: 334-9 (1960). 16p.

At first the influence of surface tension of the refrigerants on the pressure resistance of their mixtures with lubricants is discussed. At the moment when the compressor is stopped, the lubricant is subjected to the static pressure of the refrigerants. Their solubility in oils reduces surface tension and pressure resistance and may lead to rinse the lubricant and then to start with dry moving parts. Measurements of surface tension with the capillary method result in good agreement with values known or calculated from atom parachores. (auth)

**8026** (AEC-tr-6247) DESIGN AND EXPERIMENTAL STUDY OF BLADELESS DIFFUSERS FOR RADIAL-AXIAL FLOW TURBINES. A. V. Gubarev, G. A. Filippov, L. Ya. Lazarev, and A. D. Pandya. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn., from Izv. Vysshikh Uchebn. Zavedenii, Aviats. Tekhn., No. 2, 113-23(1962). 16p.

An elementary method of calculation of a bladeless diffuser is presented which allows with satisfactory accuracy the determination of geometric parameters required by the designer, and it also permits the solution of the reverse problem of calculating a variable system. The exit angle of flow from a bladeless diffuser is a function of the velocity even at pre-critical heat transmission. The efficiency of the bladeless apparatus and that of one with blades having a developed collector, are practically the same. Consequently, the bladeless apparatus allows without reducing the efficiency, a considerable reduction in weight and dimensions of the distributor of a radial-axial flow turbine. In addition, the technology for manufacture of the distributor is also facilitated. The results indicate the need for a careful manufacture of the spiral since a deviation of its geometry from the calculated one results in a distortion of the velocity field at the entrance of the turbine impeller. The studies carried out do not allow one to clearly delineate the limits of the useful application of the bladeless diffuser. However, there can be no serious objection as to the advisability of its use. (auth)

**8027** (AEC-tr-6248) DISC LOSSES IN RADIAL-AXIAL FLOW TURBINES. A. P. Tunakov. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn., from Izv. Vysshikh Uchebn. Zavedenii, Aviats. Tekhn., No. 1, 116-25 (1963). 17p.

The various recommended formulas for calculating disc losses in radial-axial flow turbines are compared, and the disc loss coefficient is shown to vary within wide limits. The concept of disc losses is defined. An experimental method and device for measuring the disc losses are described, and some experimental results are given. (D.L.C.)

**8028** (AEC-tr-6249) PREPARATION AND PRETREATMENT OF PACKING AGENTS USED FOR THE MICROANALYSIS OF CARBON AND HYDROGEN. Tetsuro Kawano, Setsuko Yamamoto, and Michiko Nakayama. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn., from Bunseki Kagaku, 1: 126-30(1952). 19p.

The results of the experiments on Pregl's packing agents can be summarized as follows: (A.) In order to obtain accurate packing reagents for the analysis of carbon and hydrogen, (1) the water washing of the reagents must be complete, and (2) $PbO_2$ should be free from oxygen and organic materials. (B.) In order to shorten the time of preheating for the control, (1) $PbO_2$ should be dried thoroughly, and (2) non-hygroscopic asbestos should be used. (C.) Care should be taken: (1) If the starting material for the asbestos preparation is inferior, in the first analysis in the morning, the % of C will be lower after a long period of use. (2) If the control value is below the normal value, then the % of C obtained in the first few analyses may be higher. However, by repeating the analysis, an accurate analysis of C can be obtained. (auth)

**8029** (AEC-tr-6250) CALCULATION OF LOSSES IN DIFFUSERS WITHOUT SEPARATION. A. E. Zaryankin. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn., from Izv. Vysshikh Uchebn. Zavedenii, Aviats. Tekhn., No. 3, 157-65(1962). 14p.

The calculation of losses in diffuser channels in turbine machinery is considered for the case of no separation of the boundary layer. It is shown that losses can be calculated accurately using only the coefficients for friction losses. Isogradient and conical diffusers and diffusers with linear velocity distribution are considered. Calculated results are compared with experimental data. (D.L.C.)

**8030** (AEC-tr-6251) OPTIMAL NUMBER OF WORKING BLADES OF DISK PUMPS. V. G. Zhuravlev. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn., from Izv. Vysshikh Uchebn. Zavedenii, Aviats. Tekhn., No. 2, 168-70(1962). 6p.

Calculations are made on the optimal number of working blades in a disk pump to ensure maximum capacity. The relative blade thickness as well as the number of blades is shown to have an effect on the delivery coefficient. The optimal number of blades is plotted vs relative blade thickness; it is seen that for the most probable relative blade thicknesses of 0.05 to 0.15, the optimal number of blades is 4 to 6. (D.L.C.)

**8031** (AEC-tr-6255) DETECTION OF TRIDIMENSIONAL VACANCY AGGLOMERATES IN QUENCHED COPPER SINGLE CRYSTALS BY THE SMALL-ANGLE SCATTERING OF X-RAYS. Alfred Seeger, Volkmar Gerold, and Manfred Ruehle. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Z. Metallk., 54: 493-504(Sept. 1963). 29p.

The agglomeration of vacancies was observed in quenched thin copper single crystals by small angle scattering of x rays. The specimens were annealed at temperatures between 20 and 200°C. It was possible to show that in crystals which had been quenched at a rate of 20,000 to 35,000°C/sec the vacancies were precipitated as voids, presumably of flat shape. Typical dimensions were: largest diameter 20 to 40Å, diameter ratio 2.5 to 4. It was possible to interpret the kinetics of vacancy precipitation almost completely by the following assumptions: (I) only voids can act as sinks for vacancies, and (II) single and divacancies take part in the diffusion process, and they are in local thermal equilibrium. The migration energy of divacancies was found to be $W_2 = 0.67$ ev; their binding en-

ergy was determined to lie between 0.13 and 0.22 ev. The most probable frequency factor for the migration of divacancies is $v_2 \exp(S_2/k) = 3 \times 10^{13}$ sec$^{-1}$, using the value B = 0.19 ev. (auth)

**8032** (AEC-tr-6246) GENERALIZED FORMULA FOR THE MEAN SQUARE ERROR OF A NON-LINEAR FUNCTION. Yu. V. Kemnits. Translated for Oak Ridge Diffusion Plant, Tenn., from Izv. Vysshikh Uchebn. Zavedenii, Geod. i Aerofotos'emka, No. 5, 75-81(1958). 10p.

The formula $my^2 = \sum_{i=1}^{n} [(\partial f/\partial x_i)\, mx_i]^2$, for calculating the mean square error of an explicit function $y = f(x_1, x_2, \ldots x_n)$ from the mean square errors of the independent variables, is generalized by the use of Jacobian determinants to permit determination of the mean square errors of implicit functions. (D.C.W.)

**8033** (AEC-tr-6165) A NEW LANGE-MATHIEU BALANCE FOR THE MEASUREMENT OF MAGNETIC SATURATION. Heinrich Lange, Rudolf Kohlhaas, and Siegfried Mueller (Cologne. Universität. Institut für Theoretische Physik). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report No. 1378, 1962. 15p.

The magnetic Lange-Mathieu balance with heterogeneous field and constant field gradient, characterized by its method of force measurement namely the combination of a highly damped balance with a pendulum, was improved by optical and electromagnetic devices that increased the sensitivity and also permitted automation of the balance. The temperature dependence of the saturation magnetization can be measured with this balance at temperatures between −170 and 1500°C. The calculation of the image effect permits a determination of the specific magnetic saturation with an accuracy of 0.1%. The possibilities of application of this magnetic balance for metallophysical processes are discussed. (auth)

**8034** (SC-T-531) POSSIBILITIES OF ERRORS IN THE MASS-SPECTROGRAPHIC SOLID-BODY ANALYSIS BY MEANS OF HIGH-FREQUENCY SPARKS FOR THE PRODUCTION OF IONS. J. Franzen and H. Hintenberger. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Z. Anal. Chem., 197: 91-7(1963). 9p.

Different ion species are produced in the electrode gap of an r-f spark in vacuum. They leave this space with strongly different energy distributions, these also being dependent on gap width. Ions with different primary energies are analyzed in a double focusing mass spectrometer by varying the acceleration potential of the ion source. A change of acceleration potential and electrode gap width results in a large change of relative ion abundances which may lead to serious errors in the analysis of the sample. The analytical accuracy is further decreased by line broadening having different magnitude for different ion species, caused by large average ion currents through the mass spectrometer. (auth)

**8035** (SC-T-532) ON THE ELECTRIC BREAKDOWN OF DIELECTRICS. J. G. Nekrasevic and J. A. Bakuto. Translated for Sandia Corp., Albuquerque, N. Mex., from Cesk. Casopis Fys., 12: 583-9(1962). 10p.

The theory of electric breakdown of dielectrics is treated from the energy point of view. Equations are derived and used to treat the cases of thermal and ionization breakdown of dielectrics, and of plastic creep in solids. (D.L.C.)

**8036** (SC-T-533) STUDIES ON SILICONE RESIN. (6) PREPARATION OF NEW ORGANOSILICON POLYMER. Kuniharu Kojima. Translated by Shyoko Hiraga (Sandia Corp., Albuquerque, N. Mex.), from Shika Zairyo Kenkyusho Hokoku, 2: No. 4, 375-87(1962). 23p.

In an attempt to improve the properties of acrylic resins for use as dental fillers, it was discovered that introducing an inorganic siloxane radical into the resin molecule improves the adhesive properties of the resin. The addition reaction of Si−H and C = C bonds was applied to diphenyl silane and bifunctional unsaturated compounds to prepare a new type of organic silicon polymer. Of the 14 bifunctional unsaturated compounds examined, diallyl phthalate gave the best addition compounds. Chloroplatinic acid and platinum black were the best catalysts for the addition reaction. The reaction mechanism was studied, and the activation energy was determined to be 12.6 ± 0.1 kcal/mole. (D.L.C.)

**8037** (SC-T-534) CONCERNING THE EXPANSION OF A POSITIVE KERNEL INTO A BILINEAR SERIES. M. D. Dol'berg. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.) from Dokl. Akad. Nauk SSSR, 120: 945-8(1958). 7p.

A generalization of Mercer's theorem regarding the expansion of a positive kernel into a bilinear series is presented. (auth)

**8038** (SC-T-535) ON THE CONNECTION OF THE MAGNETIC FIELD IN THE ATLANTIC WITH THE RELIEF OF THE OCEAN FLOOR. M. M. Ivanov. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Geomagnetizm i Aeronomiya, 3: 781-3(1963). 6p.

An analysis of measurements shows that magnetic anomalies in oceans do not depend on any particular form in the relief of the ocean floor, but are determined by a sharp magnetic inhomogeneity of rock formations constituting the crystalline foundation (basalt layer) of the ocean floor. No connection between the depth of the ocean floor and the intensity of anomalies was established. (D.C.W.)

**8039** (SC-T-536) GUARD-CAP BRUSH-PLUG. Ottmar Schnepp. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from German Patent 1,025,478. Mar. 6, 1958. Filed Mar. 12, 1955. 5p.

A protective brush plug in which a faultless fastening of the back ends of the spring wires in the brush plug to the brush plug clamp permits use of heavier spring wires is described. The wire ends in the guard cap are arranged so that they are movable inwardly in the opposite direction of their elastic force, when at rest or with the brush plug unplugged. Better contact and reduced wire breakage result. (D.C.W.)

**8040** (SC-T-537) MASS-SPECTROSCOPIC SOLID-BODY INVESTIGATIONS BY MEANS OF A DIRECT-CURRENT DISRUPTION SPARK FOR THE PRODUCTION OF IONS. K. D. Schuy and H. Hintenberger. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.) from Z. Anal. Chem., 197: No. 1, 98-106(1963). 10p.

It is shown that the disjunctive d-c spark in vacuum can successfully be used for ion production in solid source mass spectroscopy. The total ion current entering the mass analyzer is higher (in the average by a factor of 100), and the resolution of the mass spectra obtained is better than that reached on the same spectrograph with a conventional r-f spark. Typical analytical quantities, such as spark sensitivity for various elements etc., determined from a number of spectra of a stainless steel standard sample, are reproducible to within 20%. The ratio of multiply- to singly-charged ions of all elements investigated is also reproducible within 10 to 20%. Therefore, lines due to multiply-charged ions may be used for the quantitative analysis of the sample. (auth)

**8041** (UCRL-Trans-982(L)) ELECTRON MICROSCOPE INVESTIGATION OF ZINC OXIDE. Hugo Strunz and Robert Meldau. Translated by Virginia F. Simson (Univ. of California Lawrence Radiation Lab., Livermore) from Heidelberger Beitr. Mineral. Petrog., 2: 216-34 (1950). 46p.

Electron microscopic observations are presented of ZnO dusts. The following morphological types were studied: planar, isometric, linear, and pseudomorphoses. A morphological analysis of the results is given, and the bonding and reaction mechanism are discussed. (D.L.C.)

**8042** TECHNICAL PAPERS. Presented at the Tenth Annual East Coast Conference on Aerospace and Navigational Electronics, October 21, 22, 23, 1963, Baltimore, Maryland. North Hollywood, Calif., Western Periodicals Co., 1963. $9.00.

Technology in the aerospace and navigational electronics field is discussed. The topics include radiation effects, space vehicle attitude control, space environment, flight simulation, and microelectronics. Separate abstracts are presented for 8 of the 52 papers. (C.E.S.)

*For abstracts of individual papers see: 7013, 7014, 7015, 7016, 7017, 7018, 7336, and 7964.*

**8043** THE ENCYCLOPEDIA OF X-RAYS AND GAMMA RAYS. George L. Clark, ed. New York, Reinhold Publishing Corporation, 1963. 1174p. $35.00.

More than 350 articles written by over 300 authors on progress in the science of gamma rays and x rays are presented. All articles are listed alphabetically by the key word in the title. Other significant words in the title, or important sections in the text not indicated expressly by the title, are listed with reference to the actual location of the article, in a continuous running subject index throughout the book in addition to the regular subject index. An author index is also included. (M.C.G.)

# CORPORATE AUTHOR INDEX

This index contains entries for this period for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

Each entry under a corporate author is a shortened version of the title of the publication, followed by the *NSA* volume and abstract number. Report numbers are given in parentheses.

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Reactions between gaseous ammonia and S chlorides, 18: 6797 (UCRL-11081)
Structure of heavy nuclei, 18: 7698 (UCRL-11028)
Vaporization of Fe oxides, 18: 8023 (UCRL-10991)
**CALIFORNIA. UNIV., LIVERMORE. LAWRENCE RADIATION LAB.**
Computer Information Center, 18: 8022 (UCRL-7517)
Deflections and stresses in hemispherical lightweight cellular support structure, 18: 8021 (UCRL-7473)
Gamma amplifier-discriminator, 18: 7060 (UCRL-7418)
Transistorized 10-Mc decade scaler, 18: 7000 (UCRL-7567)
**CALIFORNIA. UNIV., LOS ANGELES.**

Bibliography on photographic dosimetry, 18: 7059 (UCLA-516)
Effects of plasma on absorption of Zn by mammalian erythrocytes, 18: 6597 (TID-19847)
Increased environmental radiation in Southern Nevada, 10–12/61, 18: 6951 (UCLA-518)
Particle-hole correlation in inelastic scattering of electrons from C-12, O-16, and Ca-40, 18: 7687 (NP-13427)

**CALIFORNIA. UNIV., SAN FRANCISCO. SCHOOL OF MEDICINE. RADIOLOGICAL LAB.**
Prog. rpt. on radiological research, 9/63, 18: 6621 (UCSF-23)

**CAMBRIDGE UNIV., ENGLAND.**
Cell-suspension cultures of higher plants, 18: 8015 (TID-19848)

**CANADA. DEFENCE RESEARCH CHEMICAL LABS., OTTAWA.**
Differential dose albedo measurements for 0.66-Mev $\gamma$'s incident on concrete, 18: 7839 (NP-13434)

**CARNEGIE INST. OF TECH., PITTSBURGH.**
Particle-hole correlation in inelastic scattering of electrons from C-12, O-16, and Ca-40, 18: 7687 (NP-13427)
Study of $Cu^{63}(p,pn)Cu^{62}$ reaction, 18: 7672 (CONF-30-6)

**CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC., PARR, S. C.**
Prog. rpt. on CVTR, 3–9/63, 18: 7923 (CVNA-193)
Prog. rpt. on CVTR, 10/63, 18: 7924 (CVNA-194)
Prog. rpt. on CVTR, 11/63, 18: 7925 (CVNA-197)

**CASE INST. OF TECH., CLEVELAND.**
Precipitation of In 8-hydroxyquinolate, 18: 8009 (TID-19832)
Precipitation of metal 8-hydroxyquinolates. VII., 18: 8010 (TID-19833)

**CENTRO INFORMAZIONI STUDI ESPERIENZE, MILAN.**
Research program in two-phase flow, 18: 6913 (NP-13409)

**COLOGNE. UNIVERSITÄT.**
Lange-Mathieu balance for measurement of magnetic saturation, 18: 8033 (AEC-tr-6165)

**COLORADO. UNIV., BOULDER.**
Aquation of bromopentaaquochromium(III) ion in acidic solution, 18: 8008 (TID-19817)

**COLORADO. UNIV., DENVER. SCHOOL OF MEDICINE.**
Magnesium turnover in man, 18: 7993 (CONF-355-2)

**COLUMBIA UNIV., NEW YORK.**
Ionic conductivity in NaCl, 18: 8018 (TID-19897)
Nomenclature scheme for experimental high-energy nuclear cross sections, 18: 7691 (ORNL-3499(Vol.II)(p.63-6))

**COLUMBIA UNIV., PALISADES, N. Y. LAMONT GEOLOGICAL OBSERVATORY.**
Dye-diffusion experiments on Great Bahama Bank, 18: 8012 (TID-19835)
Manganese nodules taken in Western Atlantic Abyssal-Hills Province, 18: 8011 (TID-19834)
Prog. rpt. on gas exchange between atmosphere and oceans, annual, 11/62–11/63, 18: 7592 (TID-19900)

**COMBUSTION ENGINEERING, INC., WINDSOR, CONN.**
Prog. rpt. on testing of $UO_2$ fuel systems, 7–9/63, 18: 7202 (CEND-199)

**CONNECTICUT. UNIV., NOANK. MARINE RESEARCH LAB.**
Prog. rpt. on Zn-65 in marine organisms, 12/59–11/63, 18: 6598 (TID-19922)

**CONVAIR, FORT WORTH, TEX.**
Radiation effects on solid-film lubricants, 18: 7286 (FGT-1880)

**CORNELL UNIV., ITHACA, N. Y.**
Prog. rpt. on genetic structure populations, 10/60–10/61, 18: 6618 (TID-19899)
Radiative pion–nucleon scattering, 18: 7475 (TID-19854)
Root-uptake, translocation, and loss of Cu, 18: 6594 (TID-19810)

**CORPS OF ENGINEERS.**
Detection of ruptured element at SM-1, 18: 7919 (CONF-243-38)

## D

**DEFENSE ATOMIC SUPPORT AGENCY. FIELD COMMAND, ALBUQUERQUE, N. MEX.**
Sherwood activities summary, 18: 7789 (NP-13428)

**DENMARK. ATOMENERGIKOMMISSIONEN, ROSKILDE.**
Prog. rpt. on activities, 4/62–3/63, 18: 7996 (NP-13476)

**DENMARK. ATOMENERGIKOMMISSIONEN. FORSØGSINSTITUT, RISØ.**
Environmental radioactivity in Greenland, 1962, 18: 6948 (RISO-65)
Particle-filtration efficiency of installed absolute filters, 18: 6974 (RISO-66)

**DENVER. UNIV. DENVER RESEARCH INST.**
Prog. rpt. on oxidation of beryllides, final, 9/63, 18: 7136 (DRI-2128)

**DIVISION OF TECHNICAL INFORMATION EXTENSION, AEC.**
Translation title list, 18: 8006 (TID-4025(Rev.1)(Pt.1)(Suppl.2))

**DOW CHEMICAL CO. ROCKY FLATS DIV., GOLDEN, COLO.**
Quantitative metallography of Pu, 18: 7130 (RFP-331)

**DU PONT DE NEMOURS (E. I.) & CO. METALS CENTER, BALTIMORE.**
Prog. rpt. on Nb "H" section program 7–10/63, 18: 7163 (NP-13410)

**DU PONT DE NEMOURS (E. I.) & CO. SAVANNAH RIVER LAB., AIKEN, S. C.**
Fabrication of Pu fuel, 18: 7160 (DP-838)
Irradiation of tandem-extruded joints between Zircaloy and stainless steel, 18: 7284 (DP-859)
Lattice parameters for U rod lattices in $D_2O$, 18: 7893 (DP-777)

**DU PONT DE NEMOURS (E. I.) & CO. SAVANNAH RIVER PLANT, AIKEN, S. C.**
Radioactive waste, radiation-protection standards and categorization, 18: 6712 (DPSPU-63-30-42)

## E

**ELDORADO MINING AND REFINING LTD. RESEARCH AND DEVELOPMENT DIV., PORT HOPE, ONT.**
Prog. rpt. on feed materials, 10/63, 18: 6884 (NP-13412)

**EUROPEAN ATOMIC ENERGY COMMUNITY.**
Code for solution of systems of Boolean equations, 18: 7117 (EUR-211.f)
In-pile test of thermionic converter, 18: 7457 (EUR-485.e)
Neutron distribution in critical slab, 18: 7660 (EUR-479.e)
Properties of sintered Al, 18: 7205 (EUR-433.d)

**EUROPEAN ATOMIC ENERGY COMMUNITY. EUROPEAN SCIENTIFIC DATA PROCESSING CENTER, ISPRA, ITALY.**
Code for solution of systems of Boolean equations, 18: 7117 (EUR-211.f)

**EUROPEAN ATOMIC ENERGY COMMUNITY. JOINT NUCLEAR RESEARCH CENTER, ISPRA, ITALY.**
Code for solution of systems of Boolean equations, 18: 7117 (EUR-211.f)
In-pile test of thermionic converter, 18: 7457 (EUR-485.e)
Neutron distribution in critical slab, 18: 7660 (EUR-479.e)
Properties of sintered Al, 18: 7205 (EUR-433.d)

## F

**FIAT. SEZIONE ENERGIA NUCLEARE, TURIN.**
Prog. rpt. on fission gas release from $UO_2$, 7–9/63, 18: 7285 (EURAEC-879)

**FLORIDA. UNIV., GAINESVILLE.**
Transport study of fast neutron pulses in non-moderating media, 18: 7664 (TID-19909)

**FRANCE. COMMISSARIAT À L'ÉNERGIE ATOMIQUE. CENTRE D'ÉTUDES NUCLÉAIRES, SACLAY.**
Calculation of laplacian of U rod in a cell, 18: 7898 (CEA-Note-209)
Interaction operator between two groups of particles in completely ionized plasma, 18: 7788 (CEA-2351)
Prolonged generation in air of I-131 vapor, 18: 6978 (AEC-tr-6230)

**FRANCE. SERVICE CENTRAL DE PROTECTION CONTRE LES RAYONNEMENTS IONISANTS, PARIS.**
Prog. rpt. on activities, 10/63, 18: 6949 (SCPRI(RM)X-1963)
Prog. rpt. on activities, 11/63, 18: 6950 (SCPRI(RM)XI-1963)

**FRANKFURT AM MAIN. UNIVERSITÄT.**
Bibliography on measuring instruments and methods of nuclear physics, 18: 7025 (AED-C-06-09)

## G

**GENERAL ATOMIC DIV., GENERAL DYNAMICS CORP., SAN DIEGO, CALIF.**
Improvement in thermal performance of reactor, 18: 7905 (GA-4619)
Multi-cell irradiation capsules, 18: 6911 (GA-4635)

Prog. rpt. on EBOR, 4–6/62, 18: 7926 (GA-3307)
Prog. rpt. on radiation effects on Si solar cells, 5/16–10/15/63, 18: 7287 (GA-4797)
Prog. rpt. on thermionic space power reactor system, 18: 7956 (GA-3992(Pt.I))

**GENERAL DYNAMICS/FORT WORTH. DIV. OF GENERAL DYNAMICS CORP., FORT WORTH, TEX.**
Neutron and proton spectra from targets bombarded by 160-Mev protons, 18: 7694 (ORNL-3499(Vol.II)(p.89-93))
Proton-recoil spectrometers for measuring neutron and proton energy spectra from, 18: 7051 (ORNL-3499(Vol.II)(p.109-11))
Scintillation efficiency of NaI(Tl) for charged particles, 18: 7050 (ORNL-3499(Vol.II)(p.93-4))

**GENERAL ELECTRIC CO. ADVANCED TECHNOLOGY SERVICES, CINCINNATI.**
Prog. rpt. on high-temperature materials, 11/63, 18: 7121 (GEMP-29A)
Prog. rpt. on high-temperature materials, 12/63, 18: 7289 (GEMP-30A)
Prog. rpt. on maritime nuclear steam generator, 12/63, 18: 7957 (GEMP-257)

**GENERAL ELECTRIC CO. ATOMIC POWER EQUIPMENT DEPT., SAN JOSE, CALIF.**
Compacted powder fuel rods clad with stainless steel, 18: 7161 (GEAP-4394)
Maintaining optimum power distribution throughout life, 18: 7921 (CONF-360-6)
Model for simulation of boiling water reactors, 18: 7920 (CONF-360-3)
Prog. rpt. on higher power density development, 7–9/63, 18: 7927 (GEAP-4391)
Sodium mass transfer test loop design, 18: 7137 (GEAP-3725)
Studies of $UO_2$–cladding mechanical interactions, 18: 7288 (GEAP-4088)

**GENERAL ELECTRIC CO. HANFORD ATOMIC PRODUCTS OPERATION, RICHLAND, WASH.**
Additives for improved graphite densification and radiation stability, 18: 7305 (HW-SA-3020)
Alloy selection, 18: 7292 (HW-77954(p.4.1-12))
Alloy selection, 18: 7300 (HW-78962(p.4.1-44))
Burst strength of Zy-2 pressure tubes, 18: 7297 (HW-77954(p.6.3-4))
Charging of Zy-2 with $H_2$, 18: 7209 (HW-77954(p.5.18-19))
Chemical metallurgy, 18: 7147 (HW-78962(p.5.1-12))
Containment vessel penetrations at the PRTR, 18: 7965 (HW-78491)
Corrosion of Fe- and Ni-base alloys in superheated steam, 18: 7143 (HW-77954(p.5.20-3))
Damage mechanisms, 18: 7208 (HW-77954(p.4.85-8))
Damage mechanisms, 18: 7304 (HW-78962(p.4.131-34))
Dynamic corrosion of Al, 18: 7144 (HW-77954(p.5.24-6))
Effect of $CO_2$ as inhibitor of Zr hydriding, 18: 7145 (HW-77954(p.5.31-2))
Effect of epithermal fissions in U-235 when using U as fast flux monitor, 18: 7661 (HW-77954(p.4.78-84)
Effect of thick films on hydriding of Zy-2, 18: 7146 (HW-77954(p.5.33-5))
Electrical resistance properties of Zr corrosion product, 18: 7210 (HW-77954(p.5.27-9))
Gas loop development, 18: 7212 (HW-78962(p.6.1-10))
Ground-water exchange with fluctuating rivers, 18: 6945 (HW-SA-3198)
In-reactor measurements of mechanical properties, 18: 7293 (HW-77954 (p.4.13-18))
In-reactor measurements of mechanical properties, 18: 7301 (HW-78962 (p.4.45-9))
Inconel pressure tube from DR-1 gas loop, 18: 7296 (HW-77954(p.6.1-2))
Irradiation effects, 18: 7294 (HW-77954(p.4.19-77))
Irradiation effects, 18: 7302 (HW-78962(p.4.50-126))
Irradiation of Ti, 18: 7295 (HW-77954(p.5.30))
Loop welding, 18: 7162 (HW-77954(p.6.5-11))
Management of high-level radioactive wastes, 18: 7980 (HW-SA-3279)
N-reactor pressure tubes, 18: 7860 (HW-77954(p.6.20-6))
N-reactor pressure tubes, 18: 7955 (HW-78962(p.6.20-4))
Neutron damage to metals, 18: 7290 (HW-77954(p.3.1-20))
Neutron damage to metals, 18: 7298 (HW-78962(p.3.1-14))
Oxidation and deuterium absorption of Zr alloys in $D_2O$, 18: 7142 (HW-77954(p.5.16-17))
Oxidation of superalloys, 18: 7140 (HW-77954(p.5.12-13))
Oxidation of thoria dispersion-hardened (TD) Ni, 18: 7139 (HW-77954 (p.5.5-11))
Oxidation of Zy-2 and Zr in CO and $CO_2$, 18: 7141 (HW-77954(p.5.14-15))
Plutonium physical metallurgy, 18: 7207 (HW-77954(p.3.55-83))
Plutonium physical metallurgy, 18: 7211 (HW-78962(p.3.35-60))
Prog. rpt. on metallurgy, 4–6/63, 18: 7122 (HW-77954)
Prog. rpt. on metallurgy, 7–9/63, 18: 7123 (HW-78962)
PRTR materials development, 18: 7148 (HW-78962(p.5.13-23))
PRTR pressure tubes, 18: 7929 (HW-78962(p.6.11-19))
Radiation-damage exposure units, 18: 7303 (HW-78962(p.4.127-30))
Radiological monitor for Columbia River, 18: 7044 (HW-79186)
Review of power and heat reactor designs, 18: 7852 (HW-66666(Rev.2))
Segmented core design for supercritical pressure water-cooled fast reactor, 18: 7900 (HW-SA-3149A)
Solvent extraction processes for recovery of radioactive materials, 18: 6883 (HW-SA-3211)
Swelling of irradiated fissionable materials, 18: 7291 (HW-77954 (p.3.21-54))
Swelling of irradiated fissionable materials, 18: 7299 (HW-78962 (p.3.15-34))
Treatment of radioactive condensate waste, 18: 7979 (HW-79174)
Water environment, 18: 7138 (HW-77954(p.5.1-4))

**GENERAL ELECTRIC CO. RESEARCH LAB., SCHENECTADY, N. Y.**
Photographic study of nucleate pool boiling, 18: 6919 (63-RL-3357C)
Prog. rpt. on thermionic converter, 8–10/63, 18: 7455 (AD-423257)

**GENERAL ELECTRIC CO. VALLECITOS ATOMIC LAB., PLEASANTON, CALIF.**
Measurement of burnup in reactor fuels, 18: 7903 (CONF-360-4)

**GENERAL ELECTRIC CO. VALLECITOS ATOMIC LAB., SAN JOSE, CALIF.**
Failure of type 304 stainless steel-clad swaged-powder fuel assembly, 18: 7120 (GEAP-4400)

**GENERAL MILLS, INC., MINNEAPOLIS.**
Prog. rpt. on sputtering yields, annual, 11/63, 18: 7404 (NP-13430)

**GENERAL NUCLEAR ENGINEERING CORP., DUNEDIN, FLA.**
Chloride corrosion effects on BONUS superheater materials, 18: 7928 (GNEC-257)
Prog. rpt. on hydraulic ball control system, 10–12/63, 18: 7859 (GNEC-318)

**GENERAL TELEPHONE AND ELECTRONICS LABS. INC., BAYSIDE, N. Y.**
Prog. rpt. on bonding. VIII, final, 7/62–6/63, 18: 7994 (GTR-21)

**GEOLOGICAL SURVEY, WASHINGTON, D. C.**
Geology of Jackass Flats Quadrangle, Nevada Test Site, 18: 8005 (TEI-843)
Geology of U12i and U12i.01 tunnels and lithology of U12i.01 drill hole, Nevada Test Site, 18: 8004 (TEI-842)

**GEORGIA INST. OF TECH., ATLANTA.**
Prog. rpt. on ionization of alkali ions by electron impact, 9–11/63, 18: 7405 (TID-19923)

**GOODYEAR ATOMIC CORP., PIKETON, OHIO.**
Electron metallography and diffraction studies of Al alloys, 18: 7206 (GAT-T-1121)

**GT. BRIT. MEDICAL RESEARCH COUNCIL, LONDON.**
Assay of Sr-90 in human bone, 18: 6592 (NP-13454)

**GT. BRIT. NATIONAL PHYSICAL LAB., TEDDINGTON, MIDDX., ENGLAND.**
Alloys of Au and U, 18: 7200 (AERE-X/M-100)

## H

**HARTMANN & BRAUN, A. G., FRANKFURT AM MAIN.**
Bibliography on measurement and control in reactors, 18: 7851 (AED-C-09-03)

**HARVARD UNIV., BOSTON.**
Prog. rpt. on air-cleaning studies, 7/62–6/63, 18: 6975 (TID-19850)

**HOOKER ELECTROCHEMICAL CO., NIAGARA FALLS, N. Y.**
BMP plant deactivation and standby, 18: 7110 (M-6735(Bk.VI)(Del.))
BMP plant manual, 18: 7106 (M-6735(Bk.II)(Del.))
BMP plant operating instructions, 18: 7107 (M-6735(Bk.III)(Del.))
BMP plant process development, 18: 7109 (M-6735(Bk.V)(Del.))
BMP plant services and maintenance, 18: 7108 (M-6735(Bk.IV)(Del.))
BMP plant terminal manual, 18: 7105 (M-6735(Bk.I))

**HUGHES AIRCRAFT CO., MALIBU, CALIF.**
Prog. rpt. on $H_2^+$ dissociation, final, 1/64, 18: 7406 (TID-19932)

## I

**IDAHO OPERATIONS OFFICE, AEC.**
Prog. rpt. on health and safety, annual, 1962, 18: 6971 (IDO-12033)
**ILLINOIS INST. OF TECH., CHICAGO. IIT RESEARCH INST.**
Prog. rpt. on reactor containment structures, 10/63, 18: 7865 (TID-19871)
Thermal properties of refractory alloys, 18: 7201 (ASD-TDR-63-597)
**ILLINOIS. UNIV., URBANA.**
ILLIAC-III—pattern recognition computer, 18: 8007 (TID-19713)
**ILLINOIS. UNIV., URBANA. ENGINEERING EXPERIMENT STATION.**
Mechanics of vapor bubble collapse, 18: 6927 (TID-19860)
**INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA.**
Conference on nuclear materials, Prague, 7/63. I., 18: 7256
**ISRAEL. ATOMIC ENERGY COMMISSION, REHOVOTH.**
Hydrogen bonds and structure of liquid water, 18: 6788 (IA-875)
Radionuclides according to permissible body burdens, 18: 6713 (IA-821)
**ITALY. COMITATO NAZIONALE PER L'ENERGIA NUCLEARE, BOLOGNA.**
Effectiveness of control rod, 18: 7864 (RT/FIMA(63)-2)
**ITALY. COMITATO NAZIONALE PER L'ENERGIA NUCLEARE, ISPRA.**
Amplifiers for automatic control of nuclear plants, 18: 7862 (RT/EL(63)-10)
**ITALY. COMITATO NAZIONALE PER L'ENERGIA NUCLEARE, ROME.**
Bibliography on organic reactor technology, 1/47–6/62, 18: 7854 (RT/ING(63)-27)
Determination of burnup, 18: 7906 (RT/CHI(63)-22)
Safety amplifier for reactors, 18: 7863 (RT/EL(63)-13)
Simulator for heat exchanges, 18: 6924 (RT/EL(63)-6)
**ITALY. ISTITUTO SUPERIORE DI SANITÀ, ROME.**
Conference on physics, Bari, 11/63, 18: 7339 (ISS-63/40)

## J

**JAPAN ATOMIC ENERGY RESEARCH INST., TOKYO.**
Neutron distribution in critical slab, 18: 7660 (EUR-479.e)
**JAPAN. METEOROLOGICAL AGENCY, TOKYO.**
Radiation in world during IGY-IGC. IV., 18: 6946 (NP-13423)
**JOHNS HOPKINS UNIV., BALTIMORE.**
Cross relaxation in non-Zeeman spin systems, 18: 6780 (AD-299997)
**JOHNS HOPKINS UNIV., SILVER SPRING, MD. APPLIED PHYSICS LAB.**
Computer program for equations of motion of charged particles in EM fields, 18: 7561 (NP-13471)
**JOINT INST. FOR NUCLEAR RESEARCH, DUBNA, U.S.S.R.**
Barrier penetrabilities in $\alpha$ decay, 18: 7685 (NP-13421)
Conservation of number of particles, 18: 7469 (JINR-P-139)
Crystal structures by neutron diffraction with PFR, 18: 7213 (JINR-P-1440)
Ferrite-core intermediate memory for handling information presented by radiation detector systems, 18: 7045 (JINR-E-1426)
Lifetime of long-lived $K^0$ meson, 18: 7470 (JINR-P-1423)
Modification of Hori's strong-coupling method, 18: 7468 (JINR-E-1441)
Multiple coincidence and anticoincidence circuit on tunnel diodes and transistors, 18: 7046 (JINR-P-1437)
Theory of complex angular momenta, 18: 7471 (JINR-P-1434)
Tunnel diode—operation and circuit calculations, 18: 6993 (NP-13333)

## K

**KANSAS STATE UNIV., MANHATTAN.**
Equivalent radii for $P_3$ calculations in strong absorbers, 18: 7663 (TID-19819)
**KELLOGG (M.W.) CO., NEW YORK.**
Production of H by gasification of coal using nuclear heat, 18: 7952 (CONF-117-29)
**KERNFORSCHUNGSZENTRUM, KARLSRUHE, GERMANY.**
Neutron cross sections for fast reactor materials, 18: 7680 (KFK-120 (Pt.III))
**KNOLLS ATOMIC POWER LAB., SCHENECTADY, N. Y.**
Evaluation of resonance-capture approximations, 18: 7673 (CONF-187-26)

## L

**LOCKHEED MISSILES & SPACE CO., SUNNYVALE, CALIF.**
Bibliography on biology of space flight, 18: 6587 (NP-13405)
**LONDON. UNIV. UNIVERSITY COLL.**
Applications of dispersion relations $\pi$-N and $\pi$-$\pi$ phenomena, 18: 7472 (NP-13451)
**LOS ALAMOS SCIENTIFIC LAB., N. MEX.**
Differential thermal analysis unit, 18: 6743 (LAMS-2988)
Operating instructions for Pu electrorefining plant, 18: 7124 (LA-2981)
Prog. rpt. on LAMPRE, 11/20/63, 18: 7125 (LAMS-3021)
Prog. rpt. on solid-Pu fuels program, 7–9/63, 18: 7126 (LAMS-3023)
Tests on transport containers ICC 2-R and ICC 6gJ, 18: 6972 (LAMS-2983)
**LYON. UNIVERSITÉ.**
Differential time-amplitude converter for nanosecond region, 18: 6994 (NP-13343)
Luminosity and resolving power of $\beta$ spectrograph, 18: 7048 (NP-13363)
Study of magnetic topographies with symmetry of revolution from isochronous electron trajectories, 18: 7047 (NP-13357)
Topography of magnetic fields and optics of particle orbits in FFAG accelerator, 18: 7359 (NP-13364)

## M

**MARTIN-MARIETTA CORP. AEROSPACE DIV., BALTIMORE.**
Prog. rpt. on primary cell wall, 2–10/63, 18: 8014 (TID-19844)
**MASSACHUSETTS INST. OF TECH., CAMBRIDGE.**
Dielectric constant and loss measurements on high-temperature materials, 18: 7214 (NP-13431)
Selective photography in spark chambers, 18: 7057 (TID-19841)
Void formation in initially subcooled systems, 18: 6920 (AD-424629)
**MEDICAL COLL. OF VIRGINIA, RICHMOND.**
Comparative effects of radiation and aging on eye lens, 18: 6619 (TID-19920)
**MELLON INST., PITTSBURGH.**
Techniques of radiation chemistry, 18: 6848 (RRL-125)
**MINNEAPOLIS-HONEYWELL REGULATOR CO., MINNEAPOLIS.**
Bibliography on ion propulsion, 18: 6909 (AD-406690)
**MINNESOTA. UNIV., MINNEAPOLIS.**
Generation and decay of small ions, 18: 6790 (NP-13453)
Mechanism of burnout in initially sub-cooled forced convective systems, 18: 6926 (TID-19845)
Prog. rpt. on biochemistry, final, 11/1/59–10/31/63, 18: 6976 (TID-19893)
Prog. rpt. on P-32 for *in vivo* detection of gastric cancer, final, 1963, 18: 6722 (TID-19837)
Regional blood flow measurement *in vivo*, 18: 8017 (TID-19894)
Thrust measurement analyses on two-phase flow through apertures, 18: 8013 (TID-19840)
**MONSANTO RESEARCH CORP. DAYTON LABS., OHIO.**
Thermodynamic properties of biphenyl and isomeric terphenyls, 18: 6838 (IDO-11008)
Viscosity and thermal conductivity of polyphenyls, 18: 6789 (IDO-11007)
**MOUND LAB., MIAMISBURG, OHIO.**
Bibliography on properties of Pu carbide, 18: 7127 (MLM-1169)
**MSA RESEARCH CORP., CALLERY, PENNA.**
Prog. rpt. on effect of 1200°F Na on steels, 1/62, 18: 7149 (MSAR-62-12)

## N

**NATIONAL CARBON CO., PARMA, OHIO.**
Electric and magnetic properties of pyrolytic graphite, 18: 7219 (WADD-TR-61-72(Vol.XX))
**NAVAL RADIOLOGICAL DEFENSE LAB., SAN FRANCISCO.**
Debris from underground nuclear detonation, 18: 6947 (PNE-229F)
Determination of half lives of Pm-143 and Pm-144, 18: 7701 (USNRDL-TR-684)
EEG desynchronization by x rays, 18: 6622 (USNRDL-TR-682)
Gamma rays penetrating into compartmented structure, 18: 7848 (USNRDL-TR-681)

Geometry and barrier attenuation generated by vertical slab exposed to plane Co-60 source, 18: 7847 (USNRDL-TR-677)
Heavy mass yields in slow neutron fission of $U^{233}$, 18: 7700 (USNRDL-TR-679)
Radionuclide partition for nuclear debris, 18: 6977 (USNRDL-TR-680)
**NAVAL RESEARCH LAB., WASHINGTON, D. C.**
Neutron embrittlement of reactor pressure vessel steels, 18: 7307 (NRL-5984)
**NEW BRUNSWICK LAB., AEC, N. J.**
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| | | |
|---|---|---|
| ä | becomes | ae |
| ö | | oe |
| ø | | oe |
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# SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is indentifiable by the absence of a report number.

## General Indexing Style

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Diseases and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair. However, the information would not be indexed under the experimental animal, e.g., Rats, unless the report discusses the effects on rat hair as compared with the effect on the hair of other animals.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

## Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings or, in some cases, subheadings; e.g., Amino Acids rather than Acids, amino; Helium Isotopes He-4 rather than Helium — isotopes He-4 or Helium — He-4 isotopes. Note, however, that in some cases modifying terms are used parenthetically in preference to a more direct type of entry which would result in the scattering of information. Organic compounds, however, are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of *Chemical Abstracts*, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid — methyl ester.

## Alphabetization

Main headings are arranged according to the widely accepted word-by-word alphabetic system. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out, e.g., Mesons (π), Mesons (ζ).

## Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

## Multicomponent Systems

Multicomponent alloys, except well-known trade names are indexed under each element in the alloy.

Example: Aluminum–Chromium Alloys are indexed

ALUMINUM ALLOYS
Al–Cr ...
CHROMIUM ALLOYS
Al–Cr ...

Well-known alloys such as Hastelloy are indexed directly with cross references under the element components. Multicomponent systems of elements are indexed similarly.

Example: Silicon–Tungsten Systems are indexed

SILICON SYSTEMS
Si–W ...
TUNGSTEN SYSTEMS
Si–W ...

Multicomponent systems of compounds are similarly indexed under the compound.

## Physical States of Materials

In this subject index specification of the physical state of the material, if other than normal, is included in the modifying phrase.

## Modifying Phrases (Subheadings)

Descriptive phrases (modifiers), rather than ordinary subheadings, are used under the main headings to give a better indication of the material covered in an abstract than would be possible with only a word or two whenever it appears that such information would be useful. Such phrases are written so that the idea considered most important is presented first, should a not-too-awkward expression result. However, when using this index, the reader is advised to scan all modifiers under a main heading to determine whether any abstracts in addition to the most obvious should be consulted for the desired information. Many of the modifiers are designed to be read in inverted order or to be read with the main heading inserted at the position of the comma in order to obtain a meaningful phrase; e.g., Uranium — allotropic transformation temperatures of, effect of cooling rate on is read "effect of cooling rate on allotropic transformation temperatures of uranium." In many cases, the prepositions have been omitted from such phrases provided no ambiguity results from the omission.

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| 7409 | 18-7465 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 7414 | 18-7403 | Dep.(mc); $3.60(fs), $1.37(mf) OTS |
| 7423 | 18-6782 | Dep.(mc); $2.60(fs), $0.83(mf) OTS |
| 7431 | 18-6783 | Dep.(mc); $2.60(fs), $0.83(mf) OTS |
| 7441 | 18-7990 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 7448 | 18-7991 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 7470 | 18-6991 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 7475 | 18-7992 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 7479 | 18-7029 | Dep.(mc); $2.60(fs), $0.98(mf) OTS |
| 7480 | 18-7030 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 7487 | 18-7031 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 7489 | 18-7032 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 7490 | 18-7033 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 7491 | 18-7034 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 7492 | 18-7035 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 7493 | 18-7036 | Dep.(mc); $5.60(fs), $1.82(mf) OTS |
| 7494 | 18-7037 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 7495 | 18-7038 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 7496 | 18-7039 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 7497 | 18-7040 | Dep.(mc); $2.60(fs), $0.98(mf) OTS |
| 7498 | 18-7041 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 7501 | 18-7280 | Dep.(mc); $2.60(fs), $0.89(mf) OTS |
| 7502 | 18-7281 | Dep.(mc); $3.60(fs), $1.13(mf) OTS |
| 7504 | 18-7252 | See CONF-342-2 |
| 7509 | 18-7466 | Dep.(mc); $2.60(fs), $1.10(mf) OTS |
| 7518 | 18-6784 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 7550 | 18-7658 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 7571 | 18-7918 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 7572 | 18-6882 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **CAPE–** | | |
| 1021 | 18-7941 | EM |
| **CEA–** | **(French)** | |
| 413 | 18-6978 | For translation see AEC-tr-6230 |
| 2351 | 18-7788 | Dep.(mc) |
| **CEA-Note–** | **(French)** | |
| 209 | 18-7891 | Dep.(mc) |
| **CEA-tr–** | **(French)** | |
| A-1396 | 18-6747 | Dep.(mc); $1.60(fs), $0.80(mf) JCL |
| R-1534 | 18-6851 | Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS |
| R-1709 | 18-7365 | Dep.(mc); $4.60(fs), $1.43(mf) JCL |
| **CEND–** | **(Misc.)** | |
| 199 | 18-7202 | Dep.(mc); $4.60(fs), $1.70(mf) OTS |
| **CETIS–** | **(Italian)** | |
| 53 | 18-7117 | See EUR-211.f |
| **CF–** | **(Misc.)** | |
| 2952 | 18-7561 | See NP-13471 |
| **CONF-22–** | **(American Physical Society 1963 Annual Meeting, New York, Jan. 1963)** | |
| 29 | 18-7652 | ORINS. Gmelin, AED-CONF-63-007-103 |
| **CONF-30–** | **(American Physical Society 1962 Winter Meeting in the West, Stanford, Calif., Dec. 1962)** | |
| 6 | 18-7672 | $2.60(fs), $1.07(mf) OTS; Gmelin, AED-CONF-62-257-42 |
| **CONF-45–** | **(American Ceramic Society Basic Science Division Meeting, Washington, D. C., Oct. 1963)** | |
| 1 | 18-6836 | ORINS. Gmelin, AED-CONF-63-203-1 |
| **CONF-67–** | **(Health Physics Society 8th Annual Meeting, New York, June 1963)** | |
| 36 | 18-6970 | Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-049-36 |
| **CONF-73–** | **(Sixth Biennial Conference on Carbon, Pittsburgh, June 1963)** | |
| 15 | 18-7305 | See HW-SA-3020 |
| 18 | 18-7158 | ORINS. Gmelin, AED-CONF-63-061-28 |
| **CONF-102–** | **(American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963)** | |
| 17 | 18-7945 | ORINS. American Society of Mechanical Engineers, 1963, Preprint Paper No. 63-WA-265, $1.00 |
| 20 | 18-7949 | New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-253, $1.00. ORINS |
| 21 | 18-7950 | New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-201, $1.00. ORINS |
| 22 | 18-6933 | New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-197, $1.00. ORINS |
| 23 | 18-7908 | New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-241, $1.00. ORINS |
| 24 | 18-7962 | New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-244, $1.00. ORINS |
| 25 | 18-7947 | New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-229, $1.00. ORINS |
| 26 | 18-7948 | New York, American Society of Mechanical Engineers, 1963, Paper No. 63-WA-235, $1.00. ORINS |
| 27 | 18-7462 | New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-209, $1.00. ORINS |
| 28 | 18-6938 | New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-293, $1.00. ORINS |
| 29 | 18-7255 | New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-193, $1.00. ORINS |
| **CONF-114–** | **(International Conference on High Energy Accelerators, Dubna, U.S.S.R., Aug. 1963)** | |
| 22 | 18-7028 | See BNL-7393 |
| 23 | 18-7358 | See BNL-7368 |
| 24 | 18-7364 | See PPAD-501E |
| **CONF-117–** | **(American Chemical Society 145th National Meeting, New York, Sept. 1963)** | |
| 29 | 18-7952 | Dep.(mc); $3.60(fs), $1.28(mf) OTS; Gmelin, AED-CONF-63-133-10 |
| 33 | 18-6785 | $2.60(fs), $0.86(mf) OTS; Gmelin, AED-CONF-63-133-36 |
| 35 | 18-6783 | See BNL-7431 |
| **CONF-133–** | **(International Atomic Energy Agency Symposium of Exponential and Critical Experiments with Calculations, Amsterdam, Sept. 1963)** | |

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|---|---|---|
| 37 | 18-7898 | ORINS. Vienna, IAEA, 1963, Preprint SM-42-68 |
| **CONF-134–** | **(Conference on Engineering in Medicine and Biology, Baltimore, Nov. 1963)** | |
| 12 | 18-7856 | ORINS. Gmelin, AED-CONF-63-171-7 |
| **CONF-135–** | **(International Symposium on High Temperature Technology, Asilomar, Calif., Sept. 1963)** | |
| 3 | 18-6786 | Dep.(mc); $4.60(fs), $1.61(mf) OTS; Gmelin, AED-CONF-63-135-7 |
| 6 | 18-7253 | ORINS. Gmelin, AED-CONF-63-135-8 |
| **CONF-138–** | **(11th Detroit ANACHEM Conference, Detroit, Oct. 1963)** | |
| 1 | 18-6776 | ORINS. Gmelin, AED-CONF-63-199-1 |
| **CONF-159–** | **(Proceedings of the British Ceramic Society Meeting on Point Defects in Non-Metallic Solids, Leamington Spa, England, Oct. 1963)** | |
| 1 | 18-7281 | See BNL-7502 |
| 2 | 18-7280 | See BNL-7501 |
| **CONF-168–** | **(21st Annual Meeting of the Electron Microscope Society of America, Denver, Aug. 1963)** | |
| 3 | 18-7132 | See WAPD-T-1595 |
| **CONF-172–** | **(1st Panamerican Congress of Neurology, Lima, Oct. 1963)** | |
| 1 | 18-7989 | See BNL-7394 |
| **CONF-184–** | **(Symposium on Inorganic Fluorine Chemistry, Argonne, Ill., Sept. 1963)** | |
| 3 | 18-6882 | See BNL-7572 |
| **CONF-187–** | 18-381 | **(American Nuclear Society Meeting, New York, Nov. 1963)** |
| 26 | 18-7673 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 27 | 18-7659 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 29 | 18-7905 | See GA-4619 |
| **CONF-196–** | **(American Institute of Chemical Engineers Northwest Regional Meeting, Portland, Oreg., Oct. 1963)** | |
| 1 | 18-6883 | See HW-SA-3211 |
| **CONF-202–** | **(The Electrochemical Society Fall Meeting, New York, Sept. 1963)** | |
| 4 | 18-6787 | Dep.(mc); $2.60(fs), $1.07(mf) OTS; Gmelin, AED-CONF-63-214-1 |
| 5 | 18-7461 | ORINS. Gmelin, AED-CONF-63-214-2 |
| **CONF-216–** | **(International Conference on Elementary Particles, Siena, Italy, Sept. 30–Oct. 5, 1963)** | |
| 2 | 18-7463 | See BNL-7407 |
| 3 | 18-7464 | See BNL-7408 |
| 4 | 18-7465 | See BNL-7409 |
| **CONF-227–** | **(Problems in Irradiation–Capsule Experiments Conference, Germantown, Maryland, Oct. 8-10, 1963)** | |
| 10 | 18-6911 | See GA-4635 |
| **CONF-231–** | **(International Conference on Fundamental Aspects of Weak Interactions, Upton, N. Y., Sept. 1963)** | |
| 4 | 18-7466 | See BNL-7509 |
| **CONF-243–** | **(American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963)** | |
| 38 | 18-7919 | Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-168-37 |
| 39 | 18-7867 | ORINS. Gmelin, AED-CONF-63-168-43 |
| 40 | 18-6988 | ORINS. Gmelin, AED-CONF-63-168-44 |
| **CONF-246–** | **(Solar Flare Symposium, Greenbelt, Md., Oct. 28-30, 1963)** | |
| 1 | 18-7830 | ORINS |
| **CONF-255–** | **(8th Air Cleaning Seminar, Oak Ridge, Tenn., Oct. 1963)** | |
| 10 | 18-6782 | See BNL-7423 |
| **CONF-269–** | **(International Atomic Energy Agency Symposium on Isotope Mass Effects in Chemistry and Biology, Vienna, Dec. 1963)** | |
| 2 | 18-6784 | See BNL-7518 |
| **CONF-284–** | **(National Electronics Conference on Adaptive Processes, Chicago, Oct. 1963)** | |
| 4 | 18-7827 | ORINS. Gmelin, AED-CONF-63-170-4 |
| 5 | 18-7826 | ORINS. Gmelin, AED-CONF-63-170-3 |
| 6 | 18-7825 | ORINS. Gmelin, AED-CONF-63-170-6 |
| **CONF-290–** | **(Conference on Molecular and Atomic Gas Beams, Charlottesville, Va., May 1963)** | |
| 3 | 18-7355 | ORINS. Gmelin, AED-CONF-63-147-6 |
| **CONF-293–** | **(4th Hydraulic Conference, Pullman, Wash., Oct. 1963)** | |
| 1 | 18-6945 | See HW-SA-3198 |
| **CONF-301–** | **(International Conference on the Science of Superconductivity, Hamilton, New York, Aug. 1963)** | |
| 23 | 18-7653 | ORINS. Gmelin, AED-CONF-63-148-21 |
| **CONF-303–** | **(3rd International Conference on the Mössbauer Effect, Ithaca, New York, Sept. 1963)** | |
| 13 | 18-7338 | Dep.(mc); $3.60(fs), $1.13(mf) OTS; Gmelin, AED-CONF-63-143-5 |
| 14 | 18-7356 | ORINS. Gmelin, AED-CONF-63-143-14 |
| **CONF-316–** | **(American Ceramic Society 16th Pacific Coast Regional Meeting, Los Angeles, Oct. 1963)** | |
| 1 | 18-7176 | ORINS |
| **CONF-317–** | **(Proceedings of Symposium on Photosynthesis of Green Plants, Airlie, Va., Oct. 1963)** | |
| 2 | 18-7990 | See BNL-7441 |
| 3 | 18-7992 | See BNL-7475 |
| **CONF-318–** | **(The Society of Naval Architects and Marine Engineers Annual Meeting, New York, N. Y., Nov. 1963)** | |
| 1 | 18-7963 | ORINS |
| **CONF-327–** | **(Topical Conference on Compounds Nuclear States, Gatlinburg, Tenn., Oct. 1963)** | |
| 7 | 18-7674 | Dep.(mc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-162-12 |
| 8 | 18-7675 | Dep.(mc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-162-13 |
| **CONF-328–** | **(American Physical Society Southeast Section 1963 Spring Meeting, Knoxville, Tenn., Apr. 1963)** | |
| 5 | 18-7782 | ORINS. Gmelin, AED-CONF-63-160-5 |
| **CONF-332–** | **(Symposium on Noise Analysis in Nuclear Systems, Gainesville, Fla., Nov. 1963)** | |
| 3 | 18-7892 | Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-215-3 |
| **CONF-334–** | **(Conference on Breeding Economics, and Safety in Large Fast Power Reactors, Argonne, Ill., Oct. 1963)** | |
| 5 | 18-7900 | See HW-SA-3149A |
| 11 | 18-7946 | ORINS. Gmelin, AED-CONF-63-171-6 |
| 13 | 18-7855 | ORINS. Gmelin, AED-CONF-63-171-8 |
| 15 | 18-7918 | See BNL-7571 |
| **CONF-339–** | **(The Metallurgical Society of A.I.M.E. Fall Meeting,** | |

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|---|---|---|
| | Cleveland, Oct. 1963) | |
| 3 | 18-7282 | Dep.(mc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-176-6 |
| 4 | 18-7283 | Dep.(mc); $2.60(fs), $1.01(mf) OTS; Gmelin, AED-CONF-63-176-5 |
| CONF-340– | (American Physical Society 1963 Autumn Meeting, Chicago, Oct. 1963) | |
| 2 | 18-7560 | ORINS. Gmelin, AED-CONF-63-169-1 |
| 3 | 18-7676 | Dep.(mc); $4.60(fs), $1.55(mf) OTS; Gmelin, AED-CONF-63-169-11 |
| 4 | 18-7042 | Dep.(mc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-169-12 |
| 5 | 18-7043 | $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-169-13 |
| 6 | 18-7677 | Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-169-14 |
| 12 | 18-7467 | Dep.(mc); $4.60(fs), $1.65(mf) OTS; Gmelin, AED-CONF-63-169-5 |
| CONF-342– | (Conference on Magnetism and Materials, Atlantic City, Nov. 1963) | |
| 2 | 18-7252 | ORINS. Gmelin, AED-CONF-63-218-4 |
| 3 | 18-7333 | ORINS. Gmelin, AED-CONF-63-218-7 |
| 4 | 18-7254 | ORINS. Gmelin, AED-CONF-63-218-3 |
| CONF-346– | (International Conference on Nuclear Physics with Reactor Neutrons, Argonne, Ill., Oct. 1963) | |
| 4 | 18-7783 | ORINS. Gmelin, AED-CONF-63-201-5 |
| 5 | 18-7678 | Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-201-6 |
| 6 | 18-7679 | Dep.(mc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-201-4 |
| CONF-348– | (18th Annual ACM National Conference, Denver, May 1963) | |
| 1 | 18-8007 | See TID-19713 |
| CONF-354– | (Accelerator Conference, Boston, Mass., Nov. 1963) | |
| 2 | 18-6848 | See RRL-125 |
| CONF-355– | (Symposium in Medicine, Dynamic Clinical Studies with Radioisotopes, Oak Ridge, Tenn., Oct. 1963) | |
| 2 | 18-7993 | $2.60(fs), $1.01(mf) OTS; Gmelin, AED-CONF-63-200-2 |
| CONF-356– | (1963 American Society of Metals/Metals and Materials Show, Cleveland, Oct. 1963) | |
| 2 | 18-7335 | ORINS. Metals Park, Ohio, American Society for Metals, 1963, Technical Report No. 19-3, $3.00 |
| 3 | 18-7177 | ORINS. Metals Park, Ohio, American Society for Metals, 1963, Technical Report No. 1-2, $3.00 |
| 4 | 18-7159 | Dep.(mc); $2.60(fs), $0.83(mf) OTS; Gmelin, AED-CONF-63-197-2 |
| 5 | 18-6937 | ORINS. Gmelin, AED-CONF-63-197-4 |
| CONF-357– | (National Power Conference, Cincinnati, Sept. 1963) | |
| 2 | 18-7943 | ORINS. Gmelin, AED-CONF-63-138-2 |
| CONF-358– | (American Nuclear Society Fall Meeting, Rochester, N. Y., Oct. 1963) | |
| 1 | 18-6960 | ORINS. Gmelin, AED-CONF-63-173-2 |
| CONF-359– | (American Society of Civil Engineers Annual Meeting, San Francisco, Oct. 1963) | |
| 1 | 18-7942 | ORINS. Gmelin, AED-CONF-63-198-11 |
| CONF-360– | (American Nuclear Society Topical Meeting, Nuclear Performance Power Reactor Cores, San Francisco, Sept. 1963) | |
| 1 | 18-7902 | ORINS. Gmelin, AED-CONF-63-152-2 |
| 2 | 18-7944 | ORINS. Gmelin, AED-CONF-63-152-1 |
| 3 | 18-7920 | Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-152-4 |
| 4 | 18-7903 | Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-152-3 |
| 5 | 18-7904 | Dep.(mc); $2.60(fs), $0.95(mf) OTS; Gmelin, AED-CONF-63-152-5 |
| 6 | 18-7921 | Dep.(mc); $1.10(fs), $0.80(mf) OTS; AED-CONF-63-152-6 |
| 7 | 18-7922 | Dep.(mc); $3.60(fs), $1.19(mf) OTS; Gmelin, AED-CONF-63-152-7 |
| CONF-363– | (International Symposium on Plasma Phenomena, San Diego, Calif., Oct. 1963) | |
| 5 | 18-7060 | See UCRL-7418 |
| 6 | 18-7991 | See BNL-7448 |
| 7 | 18-6991 | See BNL-7470 |
| 9 | 18-7829 | ORINS. Gmelin, AED-CONF-63-202-2 |
| 10 | 18-7828 | ORINS. Gmelin, AED-CONF-63-202-4 |
| 11 | 18-7000 | See UCRL-7567 |
| 12 | 18-7334 | ORINS. Gmelin, AED-CONF-63-202-7 |
| CONF-364– | (16th Annual Gaseous Electronics Conference, Pittsburgh, Oct. 1963) | |
| 4 | 18-7433 | ORINS. Gmelin, AED-CONF-63-185-5 |
| 5 | 18-7432 | ORINS. Gmelin, AED-CONF-63-195-4 |
| CONF-365– | (Symposium on Environmental Monitoring, Berkeley, Gloucestershire, England, Oct. 1963) | |
| 21 | 18-6775 | ORINS |
| 24 | 18-7086 | ORINS |
| CONF-366– | (General Motors Symposium on Liquids, Structures, Properties, and Solid Interactions, Warren, Mich., Sept. 1963) | |
| 1 | 18-7403 | See BNL-7414 |
| CONF-367– | (Annual Meeting of the National Technical Task Committee on Industrial Wastes, St. Louis, Mo., Dec. 1963) | |
| 1 | 18-6712 | See DPSPU-63-30-42 |
| CONF-368– | (Space-Nuclear Conference, Gatlinburg, Tenn., May 1961) | |
| 1 | 18-7102 | See K-OA-865 |
| CONF-369– | (International Symposium on Nuclear Electronics, Paris, Nov. 1963) | |
| 1 | 18-7045 | See JINR-E-1426 |
| CONF-370– | (Thermionic Converter Specialist Conference, Gatlinburg, Tenn., Oct. 1963) | |
| 1 | 18-7457 | See EUR-485.e |
| CVNA– | (Misc.) | |
| 193 | 18-7923 | Dep.(mc); $4.60(fs), $1.61(mf) OTS |
| 194 | 18-7924 | Dep.(mc); $3.60(fs), $1.28(mf) OTS |
| 197 | 18-7925 | Dep.(mc); $3.60(fs), $1.25(mf) OTS |
| D– | (Misc.) | |
| 2-35105 | 18-7203 | |
| DMIC-Memo– | (Non-AEC) | |
| 170 | 18-7204 | $2.25(OTS) |
| DP– | | |
| 777 | 18-7893 | Dep.; $1.00(OTS) |
| 838 | 18-7160 | Dep.; $2.25(OTS) |
| 859 | 18-7284 | Dep.; $0.50(OTS) |

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| **DPE-SPE–** | **(British)** | |
| 63/99/831 | 18-7866 | For translation see AERE-Trans-969 |
| **DPSPU–** | | |
| 63-30-42 | 18-6712 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **DRI–** | **(Misc.)** | |
| 2128 | 18-7136 | Dep.(mc); $7.60(fs), $2.39(mf) OTS |
| **DUBNA REPORTS** | **(Russian)** | |
| See JINR (Russian) | | |
| **EANDC(E)–** | **(European-American Nuclear Data Committee)** | |
| 35-U(Pt.III) | 18-7680 | See KFK-120(Pt.III) |
| **EUR–** | **(European Atomic Energy Community)** | |
| 211.f | 18-7117 | Dep.(mc) |
| 433.d | 18-7205 | Dep.(mc) |
| 479.e | 18-7660 | Dep.(mc) |
| 485.e | 18-7457 | Dep.(mc) |
| **EURAEC–** | | |
| 709 | 18-7907 | Dep.(mc); $2.60(fs), $0.89(mf) OTS |
| 819 | 18-7164 | Dep.(mc); $3.60(fs), $1.13(mf) OTS |
| 837 | 18-6888 | Dep.(mc); $3.60(fs), $1.25(mf) OTS |
| 879 | 18-7285 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 903 | 18-7202 | See CEND-199 |
| **FGT–** | **(Non-AEC)** | |
| 1880 | 18-7286 | |
| **FH-E–** | **(Italian)** | |
| 37 | 18-7285 | See EURAEC-879 |
| **GA–** | **(Misc.)** | |
| 3307 | 18-7926 | Dep.(mc); $8.60(fs), $3.20(mf) OTS |
| 3992(Pt.I) | 18-7956 | Dep.(mc); $2.60(fs), $1.10(mf) OTS |
| 4619 | 18-7905 | Dep.(mc); $5.60(fs), $1.88(mf) OTS |
| 4635 | 18-6911 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 4797 | 18-7287 | |
| **GAT-T–** | | |
| 1121 | 18-7206 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **GEAP–** | **(Misc.)** | |
| 3725 | 18-7137 | Dep.; $3.00(OTS) |
| 4088 | 18-7288 | Dep.(mc); $4.60(fs), $1.46(mf) OTS |
| 4391 | 18-7927 | Dep.(mc); $5.60(fs), $1.97(mf) OTS |
| 4394 | 18-7161 | Dep.(mc); $4.60(fs), $1.61(mf) OTS |
| 4400 | 18-7120 | Dep.(mc); $4.60(fs), $1.67(mf) OTS |
| **GEMP–** | | |
| 29A | 18-7121 | Dep.; $2.00(OTS) |
| 30A | 18-7289 | Dep.; $0.75(OTS) |
| 257 | 18-7957 | Dep.(mc); $9.60(fs), $3.53(mf) OTS |
| **GNEC–** | | |
| 257 | 18-7928 | Dep.(mc); $9.10(fs), $3.29(mf) OTS |
| 318 | 18-7859 | Dep.(mc); $8.10(fs), $2.69(mf) OTS |
| **GTR–** | | |
| 21 | 18-7994 | Dep.(mc); $5.60(fs), $2.00(mf) OTS |
| **HASL–** | | |
| 142 | 18-6944 | Dep.; $4.00(OTS) |
| **HW–** | | |
| 66666(Rev.2) | 18-7852 | Dep.; $4.50(OTS) |
| 77954 | 18-7122 | Dep.; $3.50(OTS) |
| 78491 | 18-7965 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 78962 | 18-7123 | Dep.; $3.50(OTS) |
| 79174 | 18-7979 | Dep.; $2.00(OTS) |
| 79186 | 18-7044 | Dep.; $0.75(OTS) |
| **HW-SA–** | | |
| 3020 | 18-7305 | Dep.(mc); $3.60(fs), $1.37(mf) OTS; Gmelin, AED-CONF-63-061-20 |
| 3149A | 18-7900 | Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-171-11 |
| 3198 | 18-6945 | Dep.(mc); $2.60(fs), $1.01(mf) OTS |
| 3211 | 18-6883 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 3279 | 18-7980 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **IA–** | **(Non-AEC)** | |
| 821 | 18-6713 | Dep.(mc) |
| 838 | 18-7510 | Nuovo Cimento (10), 30: 399-405(1963) |
| 875 | 18-6788 | Dep.(mc) |
| **IDO–** | | |
| 11007 | 18-6789 | Dep.(mc); $7.60(fs), $2.60(mf) OTS |
| 11008 | 18-6838 | Dep.(mc); $10.50(fs), $4.16(mf) OTS |
| 12033 | 18-6971 | Dep.(mc); $8.10(fs), $2.85(mf) OTS |
| 14623 | 18-6742 | Dep.; $0.50(OTS) |
| 16707 | 18-7966 | Dep.(mc); $2.60(fs), $0.89(mf) OTS |
| 16867 | 18-6922 | Dep.; $1.75(OTS) |
| 16904 | 18-7894 | Dep.; $1.25(OTS) |
| **ISS–** | **(Italian)** | |
| 63/40 | 18-7339 | Dep.(mc) |
| **JINR–** | **(Russian)** | |
| E-1426 | 18-7045 | Dep.(mc) |
| E-1441 | 18-7468 | Dep.(mc) |
| P-1394 | 18-7469 | Dep.(mc) |
| P-1423 | 18-7470 | Dep.(mc) |
| P-1434 | 18-7471 | Dep.(mc) |
| P-1437 | 18-7046 | Dep.(mc) |
| P-1440 | 18-7213 | Dep.(mc) |
| **JPL-TR–** | **(Non-AEC)** | |
| 32-441 | 18-7958 | |
| **JPRS–** | **(Non-AEC)** | |
| 22599 | 18-7220 | $0.50(OTS) |
| **K–** | | |
| 1568 | 18-6912 | Dep.; $1.25(OTS) |
| **KFK–** | **(German)** | |
| 120(Pt.III) | 18-7680 | Dep.(mc) |
| **K-OA–** | | |
| 865 | 18-7102 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 1008 | 18-7103 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 1178 | 18-7104 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| **KR–** | **(Norwegian)** | |
| 54 | 18-7901 | Dep.(mc) |
| 57 | 18-6992 | Dep.(mc) |
| 58 | 18-7853 | Dep.(mc) |
| 59 | 18-7895 | Dep.(mc) |
| 60 | 18-7995 | Dep.(mc) |
| **LA–** | | |
| 2981 | 18-7124 | Dep.; $0.75(OTS) |
| **LAMS–** | | |
| 2983 | 18-6972 | Dep.; $0.50(OTS) |
| 2988 | 18-6743 | Dep.; $1.50(OTS) |
| 3021 | 18-7125 | Dep.; $0.50(OTS) |
| 3023 | 18-7126 | Dep.; $0.50(OTS) |

| Report No. | Abstract No. | Availability |
|---|---|---|
| M– | (Misc.) | |
| 6735(Bk.I) | 18-7105 | Dep.(nc); $13.50(fs), $6.11(mf) OTS |
| 6735(Bk.II)(Del.) | 18-7106 | Dep.(nc); $21.00(fs), $10.88(mf) OTS |
| 6735(Bk.III)(Del.) | 18-7107 | Dep.(nc); $13.50(fs), $6.11(mf) OTS |
| 6735(Bk.IV)(Del.) | 18-7108 | Dep.(nc); $8.60(fs), $3.11(mf) OTS |
| 6735(Bk.V)(Del.) | 18-7109 | Dep.(nc); $2.60(fs), $0.86(mf) OTS |
| 6735(Bk.VI)(Del.) | 18-7110 | Dep.(nc); $8.60(fs), $3.08(mf) OTS |
| MATT– | | |
| 205 | 18-7815 | Phys. Fluids, 7: 151-3(1964) |
| MATT-Trans– | | |
| 10 | 18-7794 | Dep.(nc); $2.60(fs), $1.04(mf) JCL or OTS |
| 11 | 18-7795 | Dep.(nc); $3.60(fs), $1.19(mf) JCL or OTS |
| 12 | 18-7796 | Dep.(nc); $1.60(fs), $0.80(mf) JCL or OTS |
| ME-TN– | | |
| 1069-2 | 18-6927 | See TID-19860 |
| MLM– | | |
| 1167(Tr) | 18-7111 | Dep.; $0.50(OTS) |
| 1169 | 18-7127 | Dep.; $0.50(OTS) |
| MSAR– | (Misc.) | |
| 62-12 | 18-7149 | Dep.(nc); $1.10(fs), $0.80(mf) OTS |
| N– | (Misc.) | |
| 63-17101 | 18-7591 | See RM-3527-NASA |
| NBL– | | |
| 198 | 18-6744 | Dep.; $0.50(OTS) |
| NC– | (Norwegian) | |
| 48 | 18-7970 | See TID-19911 |
| 49 | 18-7969 | See TID-19910 |
| NP– | (AEC File No. for Non-AEC Reports) | |
| 13333 | 18-6993 | Dep.(nc) |
| 13343 | 18-6994 | Dep.(nc) |
| 13357 | 18-7047 | Dep.(nc) |
| 13363 | 18-7048 | Dep.(nc) |
| 13364 | 18-7359 | Dep.(nc) |
| 13406 | 18-6587 | |
| 13409 | 18-6913 | Dep.(nc) |
| 13410 | 18-7163 | Dep.(nc) |
| 13412 | 18-6884 | Dep.(nc) |
| 13415 | 18-7681 | Dep.(nc) |
| 13416 | 18-7049 | Dep.(nc) |
| 13417 | 18-6739 | Dep.(nc) |
| 13418 | 18-7682 | Dep.(nc) |
| 13419 | 18-7683 | Dep.(nc) |
| 13420 | 18-7684 | Dep.(nc) |
| 13421 | 18-7685 | Dep.(nc) |
| 13422 | 18-7686 | Dep.(nc) |
| 13423 | 18-6946 | Dep.(nc) |
| 13424 | 18-7930 | |
| 13427 | 18-7687 | |
| 13428 | 18-7789 | |
| 13430 | 18-7404 | |
| 13431 | 18-7214 | |
| 13432 | 18-6973 | |
| 13434 | 18-7839 | |
| 13436 | 18-6914 | Dep.(nc) |
| 13437 | 18-7215 | |
| 13451 | 18-7472 | Dep.(nc) |
| 13453 | 18-6790 | |
| 13454 | 18-6592 | Dep.(nc); $0.30(BIS); 1s. 6d. (HMSO) |
| 13459 | 18-6940 | |
| 13461 | 18-7340 | |
| 13463 | 18-7306 | |
| 13464 | 18-7128 | |
| 13471 | 18-7561 | |
| 13476 | 18-7996 | Dep.(nc) |
| 13478 | 18-7959 | |
| NP-tr– | (AEC File No. for Non-AEC Translations) | |
| 1080 | 18-6723 | Dep.(nc); $1.60(fs), $0.80(mf) JCL |
| 1081 | 18-6724 | Dep.(nc); $3.60(fs), $1.22(mf) JCL |
| NRL– | (Misc.) | |
| 5984 | 18-7307 | $1.00(OTS) |
| NSEC– | | |
| 88 | 18-6745 | Dep.(nc); $1.60(fs), $0.80(mf) OTS |
| NYO– | | |
| 10275 | 18-7539 | Phys. Rev., 133: B487-96(1964) |
| OCD-OS– | (Non-AEC) | |
| 62-135 | 18-6593 | |
| ORNL– | | |
| 3469 | 18-7688 | Dep.; $7.60(fs), $2.36(mf) OTS |
| 3499(Vol.II) | 18-7662 | Dep.; $2.75(OTS) |
| 3525 | 18-7695 | Dep.; $1.25(OTS) |
| 3528 | 18-6746 | Dep.; $2.00(OTS) |
| 3529 | 18-7967 | Dep.; $2.75(OTS) |
| ORNL-RSIC– | (Oak Ridge National Laboratory) | |
| 2 | 18-7846 | Dep.; Free(ORNL) |
| ORNL-TM– | | |
| 680 | 18-6934 | Dep.(nc); $7.60(fs), $2.42(mf) OTS |
| 703 | 18-6923 | Dep.(nc); $2.60(fs), $0.95(mf) OTS |
| 715 | 18-7981 | Dep.(nc); $13.00(fs), $5.66(mf) OTS |
| 734 | 18-7982 | Dep.(nc); $4.60(fs), $1.43(mf) OTS |
| 738 | 18-7861 | Dep.(nc); $1.10(fs), $0.80(mf) OTS |
| 752 | 18-6885 | Dep.(nc); $1.60(fs), $0.80(mf) OTS |
| 755 | 18-6847 | Dep.(nc); $1.10(fs), $0.80(mf) OTS |
| 761 | 18-7696 | Dep.(nc); $1.60(fs), $0.80(mf) OTS |
| OTS– | (Misc.) | |
| 63-41139 | 18-7341 | For translation see JPRS-21869 |
| 64-21207 | 18-7220 | See JPRS-22599 |
| PATENTS | (British) | 3s. 6d. each, U. K. Patent Office |
| 941,689 | 18-6875 | |
| 941,723 | 18-6845 | |
| 943,867 | 18-7089 | |
| 943,942 | 18-7192 | |
| 944,049 | 18-7975 | |
| 944,106 | 18-7019 | |
| 944,194 | 18-7868 | |
| 944,319 | 18-7193 | |
| 944,359 | 18-6876 | |
| 944,453 | 18-7869 | |
| 944,473 | 18-7090 | |
| 944,500 | 18-7976 | |
| 944,516 | 18-7909 | |
| 944,699 | 18-7910 | |
| 944,803 | 18-7870 | |
| 944,849 | 18-7020 | |
| 944,949 | 18-7194 | |
| 945,046 | 18-7021 | |
| 945,063 | 18-7133 | |
| 945,184 | 18-6907 | |
| 945,223 | 18-7654 | |
| 945,256 | 18-7195 | |
| 945,304 | 18-7871 | |
| 945,490 | 18-6679 | |
| 945,643 | 18-7951 | |
| 945,701 | 18-6877 | |

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|---|---|---|
| 945,726 | 18-7196 | |
| 945,730 | 18-6778 | |
| 945,782 | 18-6941 | |
| 945,867 | 18-7022 | |
| 946,023 | 18-7872 | |
| 946,048 | 18-7091 | |
| 946,050 | 18-6878 | |
| 946,114 | 18-7873 | |
| 946,256 | 18-7874 | |
| 946,299 | 18-7875 | |
| 946,313 | 18-6916 | |
| 946,318 | 18-6837 | |
| 946,336 | 18-7977 | |
| 946,344 | 18-7197 | |
| **PATENTS** | **(Czechoslovakian)** | |
| 97206 | 18-7370 | |
| **PATENTS** | **(French)** | |
| 78,282 | 18-6917 | See French Patent 1,261,979(Add.1) |
| 1,261,979(Add.1) | 18-6917 | |
| 1,295,655 | 18-7857 | |
| 1,298,077 | 18-7669 | |
| 1,305,950 | 18-7876 | |
| 1,310,820 | 18-7877 | |
| 1,314,188 | 18-7978 | |
| 1,314,191 | 18-7878 | |
| 1,314,343 | 18-7879 | |
| **PATENTS** | **(German)** | |
| 1,025,478 | 18-8039 | For translation see SC-T-536 |
| **PATENTS** | **(Polish)** | |
| 44394 | 18-7101 | |
| **PATENTS** | **(U. S.)** | |
| 3,114,608 | 18-6879 | |
| 3,114,688 | 18-7911 | |
| 3,114,689 | 18-7912 | |
| 3,114,690 | 18-7913 | |
| 3,114,832 | 18-7023 | |
| 3,114,834 | 18-7092 | |
| 3,114,835 | 18-7093 | |
| 3,114,837 | 18-7094 | |
| 3,114,839 | 18-7850 | |
| 3,114,945 | 18-6918 | |
| 3,115,388 | 18-6908 | |
| 3,115,408 | 18-7198 | |
| 3,115,448 | 18-7880 | |
| 3,115,450 | 18-7881 | |
| 3,115,576 | 18-6962 | |
| 3,115,578 | 18-7095 | |
| 3,115,579 | 18-6963 | |
| 3,115,591 | 18-7024 | |
| 3,116,131 | 18-7984 | |
| 3,116,210 | 18-7882 | |
| 3,116,212 | 18-7883 | |
| 3,116,213 | 18-7914 | |
| 3,116,226 | 18-6880 | |
| 3,116,413 | 18-6779 | |
| 3,116,414 | 18-7884 | |
| 3,116,417 | 18-6964 | |
| 3,116,419 | 18-6965 | |
| **PNE–** | **(Misc.)** | |
| 229F | 18-6947 | Dep.; $2.50(OTS) |
| **PPAD–** | | |
| 501E | 18-7364 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **PRDC-TR–** | | |
| 74 | 18-7931 | Dep.(mc); $1.60(fs), $0.83(mf) OTS |
| **PWA–** | **(Non-AEC)** | |
| 2125 | 18-7458 | |
| 2133 | 18-7790 | |
| **R–** | **(Misc.)** | |
| 3350-3 | 18-7128 | See NP-13464 |
| **RADC-TDR–** | **(Misc.)** | |
| 62-464(Vol.V) | 18-7790 | See PWA-2133 |
| **RADC-TR–** | **(Non-AEC)** | |
| 62-464(Vol.IV) | 18-7458 | See PWA-2125 |
| **RB–** | **(Non-AEC)** | |
| 63-3 | 18-6909 | See AD-406690 |
| **RFP–** | | |
| 331 | 18-7130 | Dep.; $0.50(OTS) |
| **RICC–** | **(Misc.)** | |
| 325 | 18-6851 | For translation see CEA-tr-R-1534 |
| **RISÖ–** | **(Danish)** | |
| 65 | 18-6948 | Dep.(mc) |
| 66 | 18-6974 | Dep.(mc) |
| **RM–** | **(Misc.)** | |
| 3527-NASA | 18-7591 | $3.60(fs), $1.13(mf) OTS |
| **RRL–** | | |
| 125 | 18-6848 | Dep.(mc); $3.60(fs), $1.31(mf) OTS |
| **RT-CHI–** | **(Italian)** | |
| (63)-22 | 18-7906 | Dep.(mc) |
| **RT-EL–** | **(Italian)** | |
| (63)-6 | 18-6924 | Dep.(mc) |
| (63)-10 | 18-7862 | Dep.(mc) |
| (63)-13 | 18-7863 | Dep.(mc) |
| **RT-FIMA–** | **(Italian)** | |
| (63)-2 | 18-7864 | Dep.(mc) |
| **RT-ING–** | **(Italian)** | |
| (63)-27 | 18-7854 | Dep.(mc) |
| **RTD-TDR–** | **(Non-AEC)** | |
| 63-3027 | 18-6615 | $3.60(OTS) |
| 63-4170 | 18-7459 | OTS |
| **SAM-TDR–** | **(Non-AEC)** | |
| 63-55 | 18-6616 | $1.10(OTS) |
| **SAN–** | | |
| 1004 | 18-6925 | Dep.(mc); $2.60(fs), $1.10(mf) OTS |
| **SC–** | **(Misc.)** | |
| 4967-(RR) | 18-7997 | Dep.(mc); $3.60(fs), $1.28(mf) OTS |
| **SC-DC–** | | |
| 3563 | 18-7998 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 3567 | 18-7999 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **SC-R–** | | |
| 742 | 18-8000 | Dep.(mc); $9.10(fs), $3.41(mf) OTS |
| **SC-T–** | | |
| 531 | 18-8034 | Dep.(mc); $1.10(fs), $0.80(mf) JCL |
| 532 | 18-8035 | Dep.(mc); $1.10(fs), $0.80(mf) JCL |

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|---|---|---|
| 533 | 18-8036 | Dep.(mc); $2.60(fs), $0.89(mf) JCL |
| 534 | 18-8037 | Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS |
| 535 | 18-8038 | Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS |
| 536 | 18-8039 | Dep.(mc); $1.10(fs), $0.80(mf) JCL |
| 537 | 18-8040 | Dep.(mc); $1.10(fs), $0.80(mf) JCL |
| **SC-TM–** | | |
| 164-57(51) | 18-8001 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 258-63(73) | 18-8002 | $3.60(fs), $1.22(mf) OTS |
| 284-63(72) | 18-6935 | Dep.(mc); $2.60(fs), $1.07(mf) OTS |
| 297-63(73) | 18-6915 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 308-63(74) | 18-8003 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **SCDC–** | | |
| 3341 | 18-7313 | See TID-19313 |
| **SCPRI(RM)–** | **(French)** | |
| X-1963 | 18-6949 | Dep.(mc) |
| XI-1963 | 18-6950 | Dep.(mc) |
| **SM–** | **(Misc.)** | |
| 50/24 | 18-6784 | See BNL-7518 |
| **SRIA–** | | |
| 105 | 18-6791 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **STI-PUB.–** | **(International Atomic Energy Agency)** | |
| 77(Vol.I) | 18-7256 | $11.00; Sch 231,-; 66s.stg; F.fr.44,-; DM 38.50 (IAEA) |
| **T–** | **(Misc.)** | |
| 2-2128 | 18-7306 | See NP-13463 |
| **TEI–** | | |
| 842 | 18-8004 | Dep.(mc); $4.60(fs), $1.43(mf) OTS |
| 843 | 18-8005 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **TID–** | | |
| 4025(Rev.1)(Pt.1) (Suppl.2) | 18-8006 | Dep.; $3.50(OTS) |
| 18596 | 18-7729 | Nucl. Instr. Methods, 24: 390-4(1963) |
| 18756 | 18-7523 | Nuovo Cimento (10), 30: 579-86(1963) |
| 18978 | 18-6632 | Exptl. Cell Res., 32: 170-4(1963) |
| 19144 | 18-7067 | Health Phys., 10: 25-9(1964) |
| 19313 | 18-7313 | Appl. Phys. Letters, 3: 185-7(1963) |
| 19334 | 18-7770 | Phys. Rev., 133: B403-8(1964) |
| 19537 | 18-7427 | Phys. Rev., 133: A632-46(1964) |
| 19677 | 18-6849 | Dep.(mc); $10.10(fs), $3.95(mf) OTS |
| 19713 | 18-8007 | Dep.(mc); $4.60(fs), $1.64(mf) OTS |
| 19810 | 18-6594 | Dep.(mc); $10.50(fs), $4.13(mf) OTS |
| 19817 | 18-8008 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 19819 | 18-7663 | Dep.(mc); $9.10(fs), $3.32(mf) OTS |
| 19832 | 18-8009 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 19833 | 18-8010 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 19834 | 18-8011 | Dep.(mc), $1.60(fs), $0.80(mf) OTS |
| 19835 | 18-8012 | Dep.(mc); $3.60(fs), $1.19(mf) OTS |
| 19836 | 18-6595 | $1.60(fs), $0.80(mf) OTS |
| 19837 | 18-6722 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 19838 | 18-6839 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 19839 | 18-6995 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 19840 | 18-8013 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 19841 | 18-7057 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 19842 | 18-6596 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 19843 | 18-6617 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 19844 | 18-8014 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 19845 | 18-6926 | Dep.(mc); $11.00(fs), $4.46(mf) OTS |
| 19847 | 18-6597 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 19848 | 18-8015 | Dep.(mc); $2.60(fs), $1.07(mf) OTS |
| 19849 | 18-7058 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 19850 | 18-6975 | Dep.(mc); $2.60(fs), $0.98(mf) OTS |
| 19851 | 18-8016 | Dep.(mc); $2.60(fs), $1.04(mf) OTS |
| 19854 | 18-7475 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 19860 | 18-6927 | Dep.(mc); $10.10(fs), $4.07(mf) OTS |
| 19871 | 18-7865 | Dep.(mc); $12.50(fs), $5.48(mf) OTS |
| 19872 | 18-7216 | Dep.(mc); $10.10(fs), $4.01(mf) OTS |
| 19877 | 18-7217 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 19893 | 18-6976 | Dep.(mc); $3.60(fs), $1.19(mf) OTS |
| 19894 | 18-8017 | Dep.(mc); $2.60(fs), $0.83(mf) OTS |
| 19895 | 18-6591 | Dep.(mc); $2.60(fs), $1.07(mf) OTS |
| 19896 | 18-7131 | Dep.(mc); $6.60(fs), $2.21(mf) OTS |
| 19897 | 18-8018 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 19898 | 18-6792 | Dep.(mc); $8.60(fs), $3.11(mf) OTS |
| 19898(App.I) | 18-6793 | |
| 19898(App.II) | 18-6794 | |
| 19899 | 18-6618 | Dep.(mc); $2.60(fs), $1.01(mf) OTS |
| 19900 | 18-7592 | Dep.(mc); $6.60(fs), $2.21(mf) OTS |
| 19901 | 18-6795 | Dep.(mc); $4.60(fs), $1.43(mf) OTS |
| 19902 | 18-6850 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 19904 | 18-6996 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 19905 | 18-6997 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 19906 | 18-6998 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 19907 | 18-6999 | Dep.(mc); $6.60(fs), $2.30(mf) OTS |
| 19908 | 18-7453 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 19909 | 18-7664 | Dep.(mc); $3.60(fs), $1.19(mf) OTS |
| 19910 | 18-7969 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 19911 | 18-7970 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 19919 | 18-6936 | Dep.(mc); $3.60(fs), $1.19(mf) OTS |
| 19920 | 18-6619 | Dep.(mc); $7.60(fs), $2.36(mf) OTS |
| 19921 | 18-8019 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 19922 | 18-6598 | Dep.(mc); $5.60(fs), $1.73(mf) OTS |
| 19923 | 18-7405 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 19929 | 18-6620 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 19930 | 18-6599 | Dep.(mc); $4.60(fs), $1.61(mf) OTS |
| 19931 | 18-7697 | Dep.(mc); $4.60(fs), $1.61(mf) OTS |
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